Volume 23, Number 16 August 31, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 31451.

31273 (K-L-6203) LABORATORY PROCEDURES FOR THE OAK RIDGE GASEOUS DIFFUSION PLANT. Hedge, W. D. (comp.) (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 1, 1968. Contract W-7405-eng-26. 806p. Dep. CFSTI.

Chemical Procedures

Refer also to abstracts 31402, 31452, and 31731.

31274 (AI-AEC-Memo-12719) ANALYSIS OF SODIUM WITH SPARK SOURCE MASS SPECTROMETER. Farrar IV, H.; Knox, C. H. (Atomics International, Canoga Park, Calif.). June 21, 1968. Contract AT(04-3)-701. 22p. Dep. CFSTI.

A spark source Mattauch-Herzog mass spectrometer was applied to the analysis of sodium metal. Modifications to the source housing allowing the sodium to be introduced to the electrodes under vacuum resulted in the elimination of unwanted oxides and polymers. Liquid nitrogen cooling of the sodium prevents melting during the analysis. The results indicate that thermal ionization does not contribute to the sodium ion beam and that the sodium metal and the impurities within it behave like other metals during RF spark analysis. Efforts to more effectively control the mass spectrometer operating conditions and to measure the sensitivity for the different elements were begun. (auth)

31275 (ARH-SA-31) PLUTONIUM ASSAY BY CONTROLLED POTENTIAL COULOMETRY. (Atlantic Richfield Hanford Co., Richland, Wash.). [1969]. 12p. (CONF-690606-1). Dep. CFSTI.

From 24th Northwest Regional Meeting, American Chemical Society, Salt Lake City, Utah.

A commercial multipurpose electroanalysis system was evaluated for precision assay of plutonium by controlled potential coulometry. Instrument design necessitated the use of electronic digital integration of electrolysis current instead of the more common capacitance type integration. Precision of individual results was 100 ± 0.15% at the 95% confidence level. (auth)

31276 (ARH-SA-32) DC ARC EXCITATION OF IMPURITIES IN PLUTONIUM DIOXIDE USING CARRIER DISTILLATION TECHNIQUES. Zilar, R. L. (Atlantic Richfield Hanford Co., Richland, Wash.). [1969]. 24p. (CONF-690606-5). Dep. CFSTI.

From 24th Northwest Regional Meeting, American Chemical Society, Salt Lake City, Utah.

The effects of various carrier compounds and methods of preparation of plutonium dioxide on the spectral emission of trace metallic impurities were studied. By using an emission spectrometer, equipped with a chart readout, excitation rates were established for elements analyzed by the carrier distillation technique. This study showed that the use of 8.3% AgCl-LiF (11:1) in plutonium dioxide gives the most sensitive and reproducible excitation for the majority of impurity elements. By proper selection of the excitation period for each element, the effect of background radiation is reduced. Spectrometric calibration curves made using data obtained in this study have a relative error of ±30% at the 95% confidence interval. (auth)

31277 (CEA-R-3752) ABSOLUTE ANALYSIS OF URANIUM ISOTOPIC CONCENTRATIONS WITH A GAS ION SOURCE MASS SPECTROMETER. Chaussy, Louis; Boyer, Robert (Commissariat a l'Energie Atomique, Pierrelatte (France)). May 1969. 25p. (In French). Dep.

A mass spectrometer with electron-bombardment ion sources for routine uranium isotopic analysis is used as a relative measurement apparatus. Such mass spectrometers can be used for absolute measurements with a very high sensitivity and precision much better than thermoionic ion-source mass spectrometers. Causes of systematic errors were examined and experimental data are given. A natural uranium sample used as reference gives: $^{235}U = 0.7202 \pm 0.0005$ at. % and $^{234}U = 0.00552 \pm 0.0003$ at. %. The use of this method is justified for standards control. (auth)

31278 (EUR-4068) ANALYTICAL CONTROL OF URANIUM MONOCARBIDE. Collin, J. L.; Laurent, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 90p. (In French). Dep.

This report presents: the synthesis of analytical studies at JRC-Ispra to control the composition of uranium monocarbide; the statistical examination of certain results; the treatment of information obtained; and the description of methods used. (auth)

31279 (GAT-T-1479) MICROANALYSIS OF ANTIMONY, IRON, AND MOLYBDENUM IN NICKEL OR URANIUM BY ATOMIC ABSORPTION SPECTROSCOPY. Walker, C. R.; Vita, O. A.; Sparks, R. W. (Goodyear Atomic Corp., Piketon, Ohio). Jan. 20, 1969. Contract AT(33-2)-1. 12p. Dep. CFSTI.

The application of atomic absorption to the microdetermination of antimony, iron, and molybdenum in nickel and uranium is described. These elements are separated and concentrated by a single solvent extraction from 8N hydrochloric acid into n-amyl acetate. The extract is then analyzed directly by atomic absorption techniques. For the 95% confidence interval, the limits of error per analysis at the 1 ppm level are ±4, ±10, and ±6% for antimony, iron, and molybdenum, respectively. In general, the procedure is more rapid and yields more accurate results than colorimetric procedures for these elements. Since the amyl acetate-hydrochloric acid solvent extraction system can separate antimony, iron, and molybdenum from gross quantities of nickel or uranium (i.e., up to 25 g), the method is capable of detecting the elements at an extremely low level of about 0.05 μg/g. (auth)

31280 (KFK-869) POLAROGRAPHIC INVESTIGATION OF AUTOMATIC DETERMINATION OF URANIUM IN FUEL SOLUTION. Thiele, D.; Baumgaertel, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Feb. 1969. 20p. (In German). (EUR-4156). Dep.

For the development of a derivative polarographic on-line analysis of Purex solutions for uranium, the disturbing influences of tributyl phosphate and ruthenium were investigated. The half-wave potentials of ruthenium nitrosyl nitrates, ruthenium(IV) nitrates, and ruthenium(III) chlorides were determined in 1.4 and 3.0M nitric acid in the presence and absence of TBP. The diffusion current of uranium showed a linear dependence on concentration in the presence of ruthenium and TBP. The standard deviation, calculated from 8 determinations, amounted to 2.2%. (tr-auth)

31281 (NIM-354) DETERMINATION OF TRACE AMOUNTS OF ARSENIC IN URANIUM TETRAFLUORIDE. Robert, R. V. D.; Russell, B. G.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). June 19, 1968. 17p. Dep.

A method was developed for determination of trace amounts of arsenic in uranium tetrafluoride. The method is based on the extraction of the arsenic as the diethyldithiocarbamate complex and its subsequent evolution as arsine. The arsine is collected in a solution of silver diethyldithiocarbamate dissolved in pyridine and

the transmittancy of the colored complex thus formed is measured spectrophotometrically. The coefficient of variation is 3.9% at a concentration of 3 ppM and 2.4% at a concentration of 40 ppM of arsenic. The lower limit of determination is 1 ppM. (auth)

31282 (UCRL-50007-68-3, pp 38-46) EFFECT OF HALOGEN COMPOUNDS ON THE MOLECULAR SPECTRA OF AIR. Nelson, G. O. (California Univ., Livermore. Lawrence Radiation Lab.).

Airborne halogen compounds were found to greatly increase the intensity of N_2 and NO molecular spectra of air in an ac spark. This phenomenon was used to measure the presence of many volatilized halogen compounds present in concentrations as low as 1 ppM. (auth)

31283 (UCRL-50007-68-3, pp 51-3) GAS CHROMATOGRAPHIC ANALYSES FOR LOW CONCENTRATIONS OF FEFO. Sanborn, E. N. (California Univ., Livermore. Lawrence Radiation Lab.).

A method was developed to determine 10^{-9} g of bis(2,2-dinitro-2-fluoroethyl)formal (FEFO) in work areas. The instrument used is an Aerograph 1520 with an electron capture detector. (M.C.G.)

31284 (Y-1676) PRESSING POWDER SAMPLES FOR SPARK-SOURCE MASS SPECTROGRAPHIC ANALYSIS. Franklin, J. C.; Rice, W. W.; Catlett, C. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). June 19, 1969. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Two methods were developed for pressing powder samples for mass spectrographic analysis. Both methods involve isostatic pressing of the sample, with or without an electrically conducting support medium, in a naphthalene mold. The methods were applied to a wide variety of matrix materials, both conducting and insulating, and were found to be structurally effective about 98% of the time. The pressure vessel in which the samples are pressed uses a mineral oil pressing fluid and provides pressures in the range of 30,000 to 180,000 psi. (auth)

31285 MASS-SPECTROMETRIC ISOTOPE ANALYSIS OF SMALL SAMPLES USING ALUMINUM OXIDE AS THE SUBSTRATE. PART 2. Zahn, H.; Schuetze, H.; Muehle, K.; Jaki, G. (Institut fuer Stabile Isotope, Leipzig. Zentralforschungsinstitut fuer Physik, Budapest). Isotopenpraxis, 5: 116-18(Mar. 1969). (In German).

Processing of Cd, Zn, and Ag samples for mass-spectrometric isotopic analysis is discussed. The mass spectra of Zn and Cd ions are shown. (M.C.G.)

31286 SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF TANTALUM IN NIOBIUM WITH MALACHITE GREEN. Grossmann, Olga (Deutsche Akademie der Wissenschaften, Berlin). Z. Anal. Chem., 245: 135-6(Apr. 17, 1969). (In German).

Traces ot tantalum are separated from niobium by extraction from hydrofluoric acid solution with methyl isobutyl ketone. The determination of the separated trace amounts of tantalum is based on their conversion to a complex with Malachite Green, the absorbance of which is measured at 635 nm. As little as 0.2 μg of tantalum can be determined in 0.5 g of niobium metal. (auth)

31287 DETERMINATION OF IMPURITIES IN METALLIC COATINGS BY SPARK MASS SPECTROGRAPHY. Vidal, Georges; Galmard, Pierre; Lanusse, Pierre (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux, France). J. Mass Spectrom. Ion Phys., 2: 373-84(May 1969). (In French).

Electroplated coatings of nickel on copper, the thickness of which lies between 7 and 300 microns, are sparked to estimate, by means of mass-spectrograph MS7, the maximum electrical charge that can be recorded without breaking through the coating. In this way it is possible to measure the lowest detectable percentage of impurities as a function of the coating thickness. This percentage varies as the inverse of the square of the thickness, which is substantiated by geometrical considerations. The detection of a 0.1-micron coating of copper on iron is extremely sensitive, and extrapolation of this result confirms the possibility of detecting a monatomic layer. 75 elements were determined as impurities in a lead coating on copper with a detection limit of 0.1 to 5 ppM in weight. The superiority of rotating electrodes compared to fixed electrodes is theoretically shown. (auth)

31288 RECENT IMPROVEMENTS OF THE SULFIDE-SILVER PROCEDURE FOR ULTRASTRUCTURAL LOCALIZATION OF HEAVY METALS. Pihl, Erik (Univ. of Umea, Sweden). J. Microscop., 7: 509-10(July 1968).

Methods are described for using U and Pb in electron microscopic ultrastructural studies. The technique included use of water-soluble glycol methacrylate as embedding resin, Pease's "inert" dehydration, conversion of naturally occurring heavy metal compounds or re-conversion of oxidized metal sulfides to sulfides on ultrathin sections, and various modification of fixation. Experiments were performed on isolated rat peritoneal cells and pancreatic islet tissue from dogs, cats, Chinese hamsters, and rats, as well as microdissected pancreatic islets from obese hyperglycemic mice. The tissue was treated according to a previously described sulfide-silver method for electron microscopy, the principle of which is that tissue heavy metals (U, Pb) were converted to sulfides by gassing the cold glutaraldehyde fixative with H_2S during the first few minutes of fixation. Cell suspensions or ultrathin Epon sections of solid tissue are then treated for 20 to 30 min with Ag ions in a protective colloid at low pH (physical development) during which procedure heavy metal sulfides reduce Ag ions forming an electron dense reaction product. Staining was performed by treating the tissue with 4% uranyl acetate for 1 hr. (BBB)

31289 DETERMINATION OF URANIUM IN ORES AND IN SOLUTION USING A PORTABLE NON DISPERSIVE X-RAY SPECTROGRAPH. Karttunen, J. O.; Harmon, W. R. (Argonne National Lab., Ill.). Spectrochim. Acta, Part B, 24: 301-11 (June 1969).

The portable nondispersive x-ray fluorescence instrument developed was tested for its application to the determination of uranium in solution, in simulated ores, and in naturally occurring ores. This instrument is composed of a small radioisotope source for excitation (cobalt-57), a compact proportional counter for detection, a miniaturized electronic package, a recorder for data presentation, and is easily contained in a one-cubic-foot volume. Using this instrument, uranium in solution was determined with a relative error of ±2.4%, and in simulated ores with a relative error of ±4.0%. The natural gamma radiation of uranium provides another analytical technique whereby with this instrument uranium in ores was determined with a relative error of ±2.0%. (auth) (UK)

31290 SPECTROPHOTOMETRIC DETERMINATION OF IRON IN HIGH-PURITY YTTRIUM OXIDE WITH 1-(2-PYRIDYLAZO)-2-NAPHTHOL. Shibata, Shozo; Goto, Kazuo; Nakashima, Ryozo (Government Industrial Research Inst., Nagoya, Japan). Anal. Chim. Acta, 46: 146-8(June 1969).

A spectrophotometric method for determining iron in high-purity yttrium oxide using 1-(2-pyridylazo)-2-naphthol is described in which the absorbance is measured at 770 nm and the optimum pH range is 3.5 to 4.5. Results show excellent agreement in samples having a wide range of iron contents. The effects of reagent concentration, color development and stability, and the effects of diverse ions were studied. The absorbance of the chloroform extract of the iron-β-PAN complex conformed to Beer's law up to ca. 2 ppM of iron. (D.H.M.)

31291 SPECTROFLUORIMETRIC DETERMINATION OF EUROPIUM AND SAMARIUM AS THEIR 2-NAPHTHOYLTRIFLUOROACETONE-TRIOCTYLPHOSPHINE OXIDE COMPLEXES. Shigematsu, Tsunenobu; Matsui, Masakazu; Wake, Ryousuke (Kyoto Univ.). Anal. Chim. Acta, 46: 101-6(June 1969).

The europium and samarium complexes with 2-naphthoyltrifluoroacetone (NTFA) can be used for the spectrofluorimetric determination of the two metals. Low concentrations of NTFA are needed, and trioctylphosphine oxide is used to enhance the extraction; the optimum pH range is 5.5 to 6.5. The fluorescence intensity is stable under irradiation for >30 min. The detection limits are 0.1 ppB Eu and 0.1 ppM Sm. Few common ions interfere; iron(III) causes low results. Rare earth ions, except samarium, in 50-fold amounts do not interfere with the determination of europium. Europium interferes with the determination of samarium, but a simultaneous determination is possible. (auth)

31292 A COMBINED ION-EXCHANGE SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF MOLYBDENUM AND TUNGSTEN IN SEAWATER. Kawabuchi, Kazuaki; Kuroda, Rokuro (Univ. of Chiba, Japan). Anal. Chim. Acta, 46: 23-30(June 1969).

A combined ion exchange spectrophotometric method was developed for the determination of molybdenum and tungsten in seawater. The two elements are adsorbed quantitatively on Dowex 1-X8 (SCN-form) from seawater adjusted to 0.1 M in hydrochloric acid and 0.1 M in ammonium thiocyanate. Molybdenum also can be concentrated quantitatively on Dowex 1-X8 (Cl-form) from seawater acidified to 0.1 M in hydrochloric acid and containing <6% hydrogen peroxide. In both concentration procedures, molybdenum and tungsten are easily eluted with 0.5 M sodium hydroxide-0.5 M sodium chloride solution. The adsorption and desorption steps provide selective concentration for molybdenum and tungsten, so that molybdenum can be determined spectrophotometrically with dithiol. Tungsten is separated from molybdenum by anion exchange on DEAE (Cl-form), and can be

determined similarly with dithiol. A seawater sample collected from the Pacific Ocean, off the coast of Kominato, Chiba, gave values of 9.5 ± 0.1 μg Mo/l and 9.3 ± 0.2 μg Mo/l for the thiocyanate concentration and hydrogen peroxide concentration methods, respectively, with 1-l samples. Duplicate analyses of seawater from the same location as for molybdenum, gave values of 0.11_5 and 0.11_6 μg/l for tungsten, on a 20-l sample basis. (auth)

31293 THE ROLE OF IRON(III) HYDROXIDE AS A COLLECTOR OF MOLYBDENUM FROM SEAWATER. Kim, Y. S.; Zeitlin, H. (Univ. of Hawaii, Honolulu). Anal. Chim. Acta, 46: 1-8(June 1969).

The behavior of iron(III) hydroxide was studied in order to clarify its role as a collector of the trace element molybdenum in seawater. Iron(III) hydroxide formed in seawater possesses a charge which is pH-dependent. At pH 4.0 the colloid has an apparent maximum positive-charge density and is able to adsorb molybdenum quantitatively as molybdate. Above pH 9 the charge is reversed and the iron(III) hydroxide no longer collects molybdate. Qualitative electrophoretic tests carried out in distilled water confirmed the positive and negative charge on the iron(III) hydroxide in acid and basic solution, respectively. At pH 10.0, calcium and magnesium salts coprecipitated molybdate in the presence or absence of iron(III) hydroxide. Procedures were worked out for the determination of molybdenum in seawater concentrated by iron(III) hydroxide at pH 4.0, and by calcium and magnesium salts at pH 10.0. (auth)

31294 A DIRECT METHOD FOR THE CHEMICAL DETERMINATION OF SERUM INORGANIC IODINE. Mantzos, J. D.; Malamos, B. (Alexandra Hospital, Athens). Clin. Chim. Acta, 21: 501-7(Sept. 1968).

A method is presented that involves isolation of serum inorganic iodine from freeze-dried serum by the following procedure: removal of protein-bound iodine with methanol, delipidization of the fraction free from protein-bound iodine; and removal of free iodoamino acids and cations by cation exchange. This procedure minimizes the addition of iodine to inorganic iodine from extraneous sources such as the reagents used. Furthermore, its application in the presence of radioactive iodoamino acids shows that it avoids contamination of the serum inorganic iodine fraction with iodine deriving from other endogenous iodine fractions. Estimation of iodine is performed after wet digestion with chloric acid. The overall recovery is about 60% and shows a satisfactory reproducibility. Comparison between the results obtained with this method and an indirect one indicated that for values of serum inorganic iodine higher than 0.1 μg% there is a good agreement between the two methods, whereas for values lower than that the indirect method produces lower values than the direct one. These results are discussed on the basis of the current knowledge of serum iodine composition. (BBB)

31295 BIAMPEROMETRIC TITRATIONS WITH CHELATING AGENTS. Vorlicek, J. (Research Inst. of Ores, Prague). Rudy (Prague), 15: 373-7(1967). (In Czech).

The principles of the technique are described, and methods for the determination of Fe, Al, Tl, Cu, In, Th, Ga, Bi, Ca, Sr, Ba, and Mg are reviewed. (24 references). (Anal. Abstr.)

Isotopic Procedures

31296 ISOTOPIC U–Pb AGES OF ZIRCONS FROM THE CENERI ZONE, SOUTHERN ALPS. Pidgeon, R. T. (Scottish Research Reactor Centre, East Kilbride); Koeppel, V.; Gruenenfelder, M. Schweiz. Mineral. Petrogr. Mitt., 48: 212-13(1968).

Six zircon samples from different rock types were analyzed isotopically for U and Pb. The apparent U–Pb ages of zircons from the orthogneiss are almost concordant (433 to 546 Myr) and indicate a major event 420 to 440 Myr ago. This event presumably led to the formation of new zircons in these rocks and it may correspond therefore in time to the major metamorphism of the higher amphibolite grade of the rocks in the Ceneri zone. By sizing a large orthogneiss zircon sample into 4 different grain size fractions a small spread of their U content and U/Pb ratios was achieved. The 3 finer fractions with the highest U content and highest U/Pb ratios yielded almost concordant ages (433 to 462 Myr). The coarsest fraction with the lowest U content and lowest U/Pb ratio yielded higher apparent ages (445 to 546 Myr), which may be due to an inherited, pre-metamorphic Pb component of their U–Pb system. After sieving and magnetic separations into 8 different fractions, the nonmagnetic fractions showed a regular increase of their U content and a decrease of the apparent ages with decreasing grain size. The magnetic fractions had a higher U content and still lower apparent ages, but did not exhibit the correlation between grain size, U content, and apparent ages found in the nonmagnetic fractions. The apparent ages indicated a minimum age of the primary source of the paragneiss zircons of 1600 to 1800 Myr. (BBB)

Radiometric Procedures

Refer also to abstracts 31396, 31522, and 31571.

31297 (ARH-SA-29) IMPROVEMENTS IN RADIOCHEMICAL ANALYSIS AND DATA REDUCTION OF ENVIRONMENTAL AIR SAMPLES. Sant, W. H.; Garland, T. R.; Roemer, J. J. (Atlantic Richfield Hanford Co., Richland, Wash.). [1969]. 21p. (CONF-690606-3). Dep. CFSTI.

From 24th Northwest Regional Meeting, American Chemical Society, Salt Lake City, Utah.

An environmental air sample radioactivity monitoring program used at the Redox Analytical Laboratory is described. A proposed revision and computerization of this program to meet the current and projected needs are outlined. The limits specified by the existing authority are referenced and explained. Methods of attaining improved lower detection limits and computer-calculated results together with computer plots of long-term data are outlined. (auth)

31298 (CONF-681032–, pp 257-75) NUCLEAR SAFEGUARDS APPLICATIONS OF ^{252}Cf. Keepin, G. R.; Walton, R. B. (Los Alamos Scientific Lab., N. Mex.).

Use of ^{252}Cf as a neutron source in nondestructive assay applications in nuclear safeguards technology and nuclear materials management is discussed. (M.C.G.)

31299 (LF-39, pp 156-64) COLLOID FILTRATION AS A PREPARATIVE METHOD FOR RADIOANALYSIS OF BIOLOGICAL SAMPLES. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

A simple, reliable, rapid, and efficient method for the radiochemical determination of polyvalent nuclides in biological samples was developed. This method consists of homogenizing the biological sample, prefiltering at pH 1, and separating the nuclide as the hydrogen phosphate by filtering through a 0.3 μ membrane filter at pH 5.0. The particulate matter filtered was of colloidal size (diameter about 0.1 μ). Radiometric yields for ^{91}Y(III), ^{144}Ce(IV), ^{155}Eu(III), and ^{147}Pm(III) in dog urine were about 97%. This procedure eliminates tedious wet ashing steps, yields thin counting samples and minimizes radiochemical and counting errors. It is an excellent procedure for weak beta emitters such as ^{147}Pm. Since it is fast and simple, this method is well suited for routine analysis of large numbers or radiobiological samples. (auth)

31300 RAPID ESTIMATION OF RADON DAUGHTER WORKING LEVELS WHEN DAUGHTER EQUILIBRIUM IS UNKNOWN. Harley, N. H.; Pasternack, B. S. (New York Univ.). Contract AT(30-1)-3136. Health Phys., 17: 109-14(July 1969).

A technique is described, based on a method due to Kusnetz, which allows radon daughter working levels to be determined after a single alpha count on a filtered air sample. The value of alpha dis/min/l determined from this count is divided by a universal factor that covers any daughter equilibrium situation, to obtain the value for working levels. The error associated with the working level value for this universal factor is less than ±25%. Factors are also derived for specific ranges of daughter equilibrium to be used when the ranges are known. Where information is available concerning the range of equilibrium, the error associated with this calculation is reduced. For example, when the range of RaA/RaB/RaC′ is known to be between 1/1/1 and 1/0.1/0.01, the error associated with the working level is no more than ±13%. The technique requires one alpha count at 30 or 40 min after the end of sampling and for this reason is a highly practical technique for use in uranium mine monitoring. A table of values is included which allows the calculation of these factors for any desired concentration or range of concentrations. (auth)

31301 THE QUANTITATIVE COLLECTION OF ^{14}C- AND TRITIUM LABELLED PRODUCTS OF COMBUSTION FOR LIQUID SCINTILLATION COUNTING. Smith, R. W.; Phillips, S. H. (National Inst. for Research in Dairying, Reading, Eng.). Int. J. Appl. Radiat. Isotop., 20: 553-5(July 1969).

A brief description is given of the technique employed for the combination of gas counting techniques with liquid scintillation counting for the assay of ^{14}C or T in biological samples. The technique involves the use of a device to allow samples of CO_2 or water to be transferred directly into a glass counting vial of the type used with a Packard scintillation spectrometer. The CO_2 is absorbed in a solution of ethanolamine in methanol. Liquid nitrogen coolant is used, with an evacuated system. The scintillator is toluene/PPO/dimethyl POPOP. For tritium-labelled water absolute ethanol is used instead of ethanolamine, and the

aqueous ethanol thus obtained may be blended with scintillator solution to give a clear monophoric system. Reproducibility is stated to be good. Counting efficiencies of about 75% were obtained for $^{14}CO_2$, and 25 to 30% for tritiated water. (UK)

31302 NOMOGRAMS FOR USE IN RESEARCH WITH RADIOACTIVE ISOTOPES. Nagy, I. (Laboratorul de Biofizica, Bucharest). Fiziol. Norm. Pathol. (Bucharest), 13: 153-9(Mar.-Apr. 1967). (In Rumanian).

Nomograms designed for estimation of specific activity of ^{45}Ca, ^{89}Sr, ^{59}Fe, ^{82}Br, ^{14}C, ^{24}Na, ^{32}P, ^{42}K, and ^{131}I, for estimation of the volume of injected dose of radioisotope calculated from dose rate (μCi/Kg) and specific activity, for the estimation of total counts required and total counting time required to reach specified relative standard errors of 1, 2, 3, 5, or 10% and to estimate cpm/g are illustrated and discussed. Examples to illustrate the use of the nomograms are given, and equations that express the mathematical relations shown graphically are listed. (BBB)

31303 ON THE METHOD OF DETERMINING ^{137}Cs IN ENVIRONMENTAL OBJECTS. Kozlova, M. V.; Lisunova, V. V. Gig. Sanit., No. 2, 52-5(Feb. 1969). (In Russian).

To isolate cesium in a radioactively pure form free of potassium and ammonium the cesium is repeatedly precipitated as the chlorotelluride, Cs_2TeCl_6, and potassium is removed by precipitation from concentrated HCl, in which cesium chloride is soluble. The method consists of sample calcination at 450°C, precipitation of strontium and rare earths as oxalates after addition of hold-back carriers, precipitation of potassium chloride from concentrated hydrochloric acid, and double precipitation of cesium telluride, Cs_2TeCl_6, by addition of a solution of tellurium dioxide in concentrated HCl. The Cs_2TeCl_6 precipitate is weighed to obtain the chemical yield, and the ^{137}Cs activity is spread on polystyrol disks and counted on a low-background counter. The chemical purity of the separated cesium was verified by flame photometry. The method gives results that are comparable to those obtained by the bismuth iodide method. (TTT)

31304 BREATH ANALYSIS FOR ^{14}C. Kennally, J. R. (New England Nuclear Corp., Boston). Health Phys., 16: 813 (June 1969).

Determination of the specific activity of CO_2 in human breath is a convenient way to estimate internal dose due to ingested ^{14}C. A breath sample is collected by blowing up a balloon to a diameter of approximately 14 in. (20 to 30 mmoles of CO_2 will be contained in such a balloon.) The gas in the balloon is allowed to escape through a disposable pipette into a liquid scintillation counting vial. If the carbon in the body tissues is assumed to have the same specific activity as the carbon in the breath CO_2, 300 pCi/mmole corresponds to a 300 μCi body burden for a 70 kg adult. For chronic invariant exposures the equation is given. (auth) (UK)

31305 CONTRIBUTIONS TO THE URANIUM CONTENT DETERMINATIONS IN SOLUTIONS BASED ON ^{238}U DAUGHTER RADIOACTIVITY MEASUREMENTS. Bunus, F.; Matei, I. (Ministry of Mines, Bucharest). Rev. Roum. Chim., 14: 333-7 (Mar. 1969).

The applicability of a fast uranium content determination in solution was studied. The method is based on uranium (daughters) radioactivity measurements in solutions. In doing so the uranium radioactive daughters were taken into consideration as the influence upon the precision and the limited field of applications involved. Measurements on standard solutions and samples were made. (auth)

Activation Procedures

Refer also to abstracts 31326 and 31398.

31306 POSSIBILITIES OF NITROGEN DETERMINATION IN SEEDS BY DIRECT NUCLEAR REACTIONS. Johansson, A. (Gustaf Werner Inst., Uppsala); Larsson, B.; Tibell, G.; Ehrenberg, L. pp 169-71 of New Approaches to Breeding for Improved Plant Protein. Vienna, International Atomic Energy Agency, 1969.

From Panel Meeting on New Approaches to Breeding for Improved Plant Protein, Roestanga, Sweden. See STI/PUB-212; CONF-680655.

It was demonstrated in experiments with single maize kernels that direct nuclear reactions with medium-energy protons (185 MeV) may be used for a very fast determination of the nitrogen content in comparison with the contents of carbon and oxygen. For the determination of nitrogen in these in-beam measurements the reaction $^{14}N(p,d)^{13}N$ seems the most suitable. The analysis may be arranged without irradiation of the embryo. (auth)

31307 DETERMINATION OF NITROGEN IN PLANT SEEDS BY FAST NEUTRON ACTIVATION ANALYSIS. Kosta, L. (Josef Stefan Nuclear Inst., Ljubljana, Yugoslavia); Ravnik, V.; Dumanovic, J. pp 161-8 of Panel Meeting on New Approaches to Breeding for Improved Plant Protein, Roestanga, Sweden. Vienna, International Atomic Energy Agency, 1969.

From Panel Meeting on New Approaches to Breeding for Improved Plant Protein, Roestanga, Sweden. See STI/PUB-212; CONF-680655.

With the aim of developing a fast method for the determination of protein in seeds, the activation of nitrogen by $^{14}N(n,2n)^{13}N$ was studied using 15-MeV neutrons. Samples were irradiated under well-defined and reproducible geometrical conditions together with monitors calibrated to standard samples. Good agreement was demonstrated between values obtained by the activation technique and by the Kjeldahl method. The nitrogen content of single seeds of maize may be determined with sufficient accuracy at neutron doses around 200 rad while leaving the seeds viable. (auth)

31308 NON-DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF THE ALLENDE METEORITE. Emery, J. F.; Strain, J. E.; O'Kelley, G. D.; Lyon, W. S. (Oak Ridge National Lab., Tenn.). Radiochem. Radioanal. Lett., 1: 137-41(June 1969).

Fourteen elements, O, Fe, Si, Mg, Ca, Al, Ni, Cr, K, Mn, Co, Sc, Hf, and U, were determined in the Allende meteorite that fell February 8, 1969 in Mexico. Ge(Li) and NaI(Tl) spectroscopy were used to identify the nuclides induced by reactor irradiation. Two elements were determined by 14-MeV neutron activation. (auth)

31309 RESONANCE NEUTRONS IN ACTIVATION ANALYSIS. Proza, Zdenek; Rakovic, Miloslav (Karlova Univ., Prague). Chem. Listy, 63: 257-72(Mar. 1969). (In Czech).

The literature (57 references, mostly in English) on resonance neutrons and their use in activation analysis is reviewed. Resonance maxima are discussed, and the theory of resonance-neutron activation analysis is reviewed briefly. A diagram of a neutron spectrometer is presented. Problems of self-absorption are discussed, including the self-absorption factor and calculation of the effective resonance integral. The use of resonance neutrons in selective activation analysis and in analysis of samples with a high effective cross-section in thermal neutrons is considered. Some examples are manganese in biological material and chloride in cadmium chloride. (TTT)

31310 TRACE ACTIVATION ANALYSIS OF ELEMENT GROUPS WITH COMPUTER REDUCTION OF Ge(Li) SPECTRA. Case, D. R.; Laul, J. C.; Lipschutz, M. E.; Schmidt-Bleek, F. (Purdue Univ., Lafayette, Ind.). Radiochem. Radioanal. Lett., 1: 143-7(June 1969).

Trace amounts of As, Au, Co, Sc, Ga, Ge, Hg, Mo, Os, Re, Sb, Sc, Se, Te, and Zn in stony meteorites were determined by neutron activation. The irradiated samples were dissolved. Then several groups of elements were separated by various chemical methods, and the chemical yield of each element was determined by re-irradiation. The developed linear least squares computer routine combined all the information to yield ppM information directly. (auth)

31311 ON THE FEASIBILITY OF THE DETERMINATION OF WATER, SALT, AND SULPHUR IN CRUDE OIL BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Gorski, L.; Janczyszyn, J.; Loska, L. (Inst. of Nuclear Techniques, Krakow). Radiochem. Radioanal. Lett., 1: 99-109(June 1969).

An apparatus was designed and constructed for continuous measurement of water, salt, and sulfur in crude oil by means of 14-MeV neutron activation. Measurements confirmed the possibility of salt and water determination in the range of 0.01 to 6 g/l and 0.1 to 1.6 g/l, respectively. (auth)

31312 THE DETERMINATION OF PHOSPHORUS AND NITROGEN IN HERBAGE FLOUR BY FAST NEUTRON ACTIVATION ANALYSIS. Prapuolenis, A. A.; Bakes, J. M. (Univ. of Reading, Eng. Warren Spring Lab., Stevenage, Eng.). Radiochem. Radioanal. Lett., 1: 19-23(May 1969).

The determination of N and P in grass and clover flours by fast neutron activation analysis and γ spectrometry is discussed. The technique is non-destructive and rapid. The results showed that in red clover flour there is about twice as much N and P in the leaves as in the stalks. Grass flours contain somewhat less phosphorus in the leaves than in the stalks, but the general level of P is higher than in red clover. The amount of N in the herbage flour depends on the degree of drying and is inversely proportional to the temperature and time of heating. (P.C.H.)

31313 NON-DESTRUCTIVE DETERMINATION OF THE ISOTOPIC RATIO $^{235}U/^{238}U$ BY ACTIVATION ANALYSIS. Frana, J.; Vobecky, M.; Kristak, J. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett., 1: 41-9(May 1969).

The isotopic ratio, $^{235}U/^{238}U$, was determined using nondestructive neutron activation analysis. The abundance of ^{235}U in samples

studied was determined from the intensity changes of γ peaks due to the decay of ^{239}Np and of γ peaks of many-fission products, compared with those related to the simultaneously irradiated standard sample (natural uranium). The γ-ray spectra were measured by means of a Ge(Li) detector. The samples were irradiated for 30 to 120 minutes at about 10^{12} n/cm^2/sec and measured approximately 70 hours after irradiation. The method described is applicable for mixtures of ^{235}U and ^{238}U in the range from a few tenths percent to several tens percent of ^{235}U. (auth)

31314 A RAPID METHOD OF DATA REDUCTION IN ACTIVATION ANALYSIS. Inouye, T. (Toshiba Research and Development Center, Kawasaki, Japan). Radiochem. Radioanal. Lett., 1: 63-8(May 1969).

A new computer code for activation analysis was developed based on a previously reported Fourier transform method. The new technique of sectioning reduced the calculation time to 8 sec using a GE-635 computer. (auth)

31315 A SIMPLIFIED METHOD FOR THE DETERMINATION OF ARSENIC IN HUMAN NAIL AND HAIR BY ACTIVATION ANALYSIS USING A Ge(Li) DETECTOR. Minagawa, Y.; Kamegaya, K. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Radiochem. Radioanal. Lett., 1: 69-73(May 1969).

The determination of arsenic in human nail and hair was performed by activation analysis using a Ge(Li) detector. Previously reported activation procedures required the separation of arsenic from the irradiated sample. Arsenic was determined by a simplified procedure with one step that removes bromine, with a sensitivity of 0.1 ppM. (auth)

31316 CHELATE ENHANCEMENT OF THE SENSITIVITY FOR MAGNESIUM IN NEUTRON ACTIVATION ANALYSIS. Smathers, James B.; Duffey, Dick; Lakshmanan, Sitmara (Texas A and M Univ., College Station). Anal. Chim. Acta, 46: 9-15 (June 1969).

A chelation technique is described in which the high sensitivity of neutron activation analysis for bromine is used to improve the activation sensitivity for magnesium. Magnesium is extracted with 5,7-dibromo-8-hydroxyquinoline in chloroform in the presence of 2,4,6-trimethylpyridine, the chelate is isolated by paper chromatography, and the amount of magnesium present is calculated from the bromine activity after activation. Experimental variables are discussed. The sensitivity limit for magnesium is ca. 0.1 μg. (auth)

31317 EPITHERMAL NEUTRON ACTIVATION ANALYSIS FOR IODINE IN SMALL AQUEOUS SAMPLES. Brune, D. (Aktiebolaget Atomenergi, Studsvik, Sweden). Anal. Chim. Acta, 46: 17-21(June 1969).

Selective activation by means of epithermal neutrons is discussed in the light of the Westcott nomenclature. Expressions for the calculation of the "advantage" factor when epithermal activation is used, are given. The epithermal activation technique was applied to the determination of iodine at the microgram level in aqueous solutions containing iodine and chlorine in the ratio of about 1:2000. Aqueous samples as small as 50 μl were irradiated while frozen. (auth)

31318 DETERMINATION OF IMPURITIES IN TITANIUM AND TITANIUM DIOXIDE BY NEUTRON ACTIVATION ANALYSIS. PART II. DETERMINATION OF 27 TRACE CONSTITUENTS IN TITANIA POWDER. Neirinckx, R.; Adams, F.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 46: 165-78(July 1969).

A procedure for the determination by neutron activation of the most important impurities in titania is described. It is based on reactor irradiation of 50-mg amounts of sample. The activities are separated in six subgroups mostly by anion exchange. The method allows the determination of antimony, arsenic, barium, calcium, chromium, cobalt, copper, gallium, gold, hafnium, indium, iron, manganese, molybdenum, nickel, potassium, rare earths, silver, sodium, tantalum, thorium, tin, tungsten, uranium, and zinc. The reproducibility and the accuracy of the analytical results are satisfactory. The sensitivity ranges from 5×10^{-4} μg (10 ppB in 50 mg of sample) for arsenic and gold up to 5 μg for tin. (auth)

31319 ACTIVATION ANALYSIS OF PAPER CHROMATOGRAMS. Budzynski, A. Z.; Beer, J. Z. (Inst. of Nuclear Research, Warsaw). Anal. Chim. Acta, 46: 281-306(July 1969).

The use of activation analysis in conjunction with paper chromatography, and particularly activation after chromatography, is reviewed. Irradiation facilities, the use of markers, internal standards, and general activation conditions are discussed, and detailed attention is given to the behavior of various types of paper on activation, with especial reference to stability and impurities. Practical applications dealing with phosphorus, oxygen, iodine, arsenic, and various metals are reviewed. (88 references). (auth)

31320 ACTIVATION ANALYSIS OF NITROGEN WITH 14-MeV NEUTRONS USING ALUMINUM AS INTERNAL STANDARD. Ishii, Daido; Jinno, Kiyokatsu (Nagaya Univ., Japan). Kogyo Kagaku Zasshi, 72: 656-60(Mar. 1969). (In Japanese).

In 14-MeV neutron activation determination of nitrogen, a change in analytical conditions, especially that of neutron flux, is inevitable and this makes the precision lower. This defect was improved by the use of aluminum as an internal standard material. Since ^{27}Mg produced by the reaction ^{27}Al(n,p)^{27}Mg has a similar half-life to ^{13}N produced by ^{14}N(n,2n)^{13}N, the activity of the latter is conveniently normalized by that of the former. The sample and the aluminum plate are put into a capsule and irradiated. The activity is then measured by γ scintillation spectrometry. This internal standard method was applied to determine nitrogen in various compounds. As a result, a straight line was obtained as the calibration curve for the nitrogen determination with relative errors less than 2.7% for 0.1 to 1.4 g of nitrogen. This method is useful as an analytical procedure for nitrogen determination by neutron activation analysis. (auth) (NSA of Japan)

31321 THE DETERMINATION OF URANIUM IN STONY METEORITES BY REGISTRATION OF FISSION FRAGMENT TRACKS. Genaeva, L. L; Kashkarov, L. L.; Lavrukhina, A. K. Meteoritika, No. 28, 102-6(1968). (In Russian).

Samples of meteorites were prepared in the shape of a plate with an area of about 0.1 to 0.5 cm^2 and a thickness of about 0.1 mm. One surface was polished to mirror brightness and a band of lawsan was applied. The samples, together with a control steel plate containing 10^{-6} g/g of U, were wrapped in Al foil and irradiated by a neutron beam from a reactor. The integrated fluxes of thermal, intermediate, and fast neutrons were 8.9×10^{17}, 8.1×10^{16}, and 5.9×10^{16} n/cm^2. The errors in determining the U content in meteorites by the fission fragment track method are caused by the statistical errors in determining the density of individual tracks, the neutron flux, and the effective thickness of the surface layer of the sample. It was established that this method can be used to determine the U content down to 10^{-13} g/g. The results of the U content determination of the Sikhote–Alin and Arus meteorites are tabulated. The results indicate that the Sikhote–Alin meteorite has three regions having maximum U content, while the Arus meteorite has uniform U distribution. (JPRS)

31322 RHENIUM AND NONRADIOGENIC OSMIUM IN AUSTRALIAN MOLYBDENITES AND OTHER SULFIDE MINERALS BY NEUTRON ACTIVATION ANALYSIS. Morgan, J. W.; Lovering, J. F.; Ford, R. J. J. Geol. Soc. Aust., 15: 189-94(1968).

Neutron activation analyses for Re and nonradiogenic Os abundances were performed in molybdenites and other sulfide minerals, mostly from Tasmanian localities. For these mineral samples in which the Re abundance was expected to be high, a low flux of 3×10^{12} n/cm^2/sec was used. After irradiation, samples were transferred to Zr crucibles; Re and Os carriers were added; samples were brought into solution by fusion and dissolution in N HCl. The solution was passed through a small anion exchange column; Os was eluted in 0.8N nitric acid and Re in 2.3N nitric acid. Osmium was further purified by precipitation as the hydrous dioxide, extraction into chloroform as the tetroxide, and finally precipitated as Os $(NH_2 \cdot CS \cdot NH_2)_6Cr(SCN)_6$. Rhenium was purified by extraction from H_2SO_4 solution into isoamyl alcohol in the presence of hydrazine, which prevented the extraction of Tc. After being back-extracted into alkaline solution, Re was finally precipitated as tetraphenyl arsonium perrhenate. Radioactivity was measured by β counting. Osmium determination by neutron activation is insensitive to ^{191}Os, which, on radiative neutron capture, yields the stable nuclide ^{188}Os. For this reason this method cannot be used for age determinations by the Re–Os method as only the nonradiogenic Os isotopes are determined by this method. (BBB)

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Refer also to abstracts 31399, 31411, and 33046.

31323 (CEA-R-3792) ELECTROCHEMICAL PROPERTIES OF URANIUM, CERIUM, AND ZIRCONIUM IN THE LITHIUM FLUORIDE–BARIUM FLUORIDE EUTECTIC. Cartier, Rene (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1969. 55p. (In French). Dep.

The possibility of carrying out an electrochemical analysis of the ions U^{4+}, Ce^{3+}, and Zr^{4+} in a fluoride melt was studied, and some of the electrochemical properties of these ions were obtained. It was necessary to develop a method for purifying the $LiF-BaF_2$ eutectic so as to have melts of sufficient purity for carrying out an electrochemical study using linear chronoam-

perometry and chronopotentiometry. The polarization curves recorded in solutions for the ions U^{4+}, Ce^{4+}, and Zr^{4+} show that the systems U^{4+}/U^{3+}, Ce^{3+}/Ce^{4+}, and Zr^{4+}/Zr are rapid. After it was checked that mass transport on the electrode is controlled by diffusion, the diffusion coefficients for the ions Ce^{3+}, U^{4+}, and Zr^{4+} were determined. The oxidizing nature of the ion Ce^{4+} makes it possible to dissolve ceric oxide in the molten fluoride. Furthermore the existence of two zirconium oxyfluorides was demonstrated; they appear after dissolution of the zirconia in a solution of zirconium tetrafluoride. These results are of interest for the preparation of metals by electrolytic reduction of their oxides. (auth)

31324 (COO-1043-2) RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. Period Covered: June 1, 1967-January 31, 1968. Yang, N. C. (Chicago Univ., Ill. Dept. of Chemistry). Feb. 16, 1968. 4p. Dep. CFSTI.

The production of cyclopropanes by photolysis of polyhalomethanes in olefins was studied. Yields of up to 86% were obtained and only a slight excess of the olefin was needed. It was demonstrated that the cyclopropanes are formed by the insertion of a divalent carbon intermediate directly into the olefins without the formation of radical intermediates. (M.C.G.)

31325 (GA-8771) CESIUM SORPTION IN MATERIALS FOR INTEGRAL RESERVOIRS. Yates, M. K.; Fitzpatrick, G. O. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 1968. Contract AT(04-3)-167. 24p. (CONF-681059-2). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Boston, Mass.

The cesium vapor pressure/sample temperature/sample loading characteristics were measured for several types of graphite. The isotherms for different types of graphite were similar, but the transition between two cesium-graphite equilibrium states was better defined in some samples than in others. Hysteresis effects were present in most samples but appear to pose no particular problems to the thermionic converter. A long-term thermal stability test was begun on one sample of graphite, which was operated at 775°C at a cesium vapor pressure of 10 torr. Three thousand three hundred sixty (3360) hours were accumulated with no changes detected in the sample's pressure temperature characteristics. The required temperature control accuracy for some sorption reservoirs is shown to be approximately one-half that required for a liquid cesium reservoir, and tolerable cesium losses in sorption reservoirs are given for a given cesium vapor pressure change. (auth)

31326 (GA-8772) CHEMICAL VAPOR DEPOSITION OF TUNGSTEN. Chin, J.; Horsley, J. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 1968. Contract AT(04-3)-167. 14p. (CONF-681059-1). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Boston, Mass.

A study of process parameters relative to the fluorine content of chemically vapor-deposited tungsten, a key feature in stability of emitters for thermionic application is described. Fluorine contents of tungsten deposits were found to be an inverse function of the deposition temperature and $H_2:WF_6$ ratio. Deviations in fluorine content measurements in vapor-deposited tungsten are sometimes larger than proposed allowable fluorine limits. Activation analysis is being evaluated as a method of measuring low fluoride concentrations in tungsten. Principle problems with activation analysis of fluorine are caused by gamma attenuation correction factors and a lack of suitable standards. (auth)

31327 (LF-39, pp 165-71) ANALYSIS OF CASCADE IMPACTOR DATA BY A WEIGHTED LEAST SQUARES METHOD. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The aerodynamic size distributions of various radioactive aerosols used in this program were routinely characterized with a seven-stage round-jet cascade impactor. A rigorous mathematical technique was developed to fit a log-normal function to the activity distribution of aerosols with impactor data. This method employs the efficiency characteristics of each impactor stage for each particle size to fit the impactor data by a weighted least-squares regression analysis with the weight of each datum equal to the inverse of its estimated variance. Estimates of the confidence limits of the fitted parameters were also made. The results of using this technique to characterize 50 actual samples are compared with those obtained from graphical and the "effective cut-off diameter" methods. This least-squares technique can be easily adapted to fitting any explicit mathematical function to the cascade impactor data. (auth)

31328 THE COMPOUNDS OF LANTHANUM, YTTRIUM, SCANDIUM, AND THORIUM WITH TRIOXYGLUTARIC ACID. Poskrebysheva, L. M.; Skorik, N. A.; Serebrennikov, V. V. Radiokhimiya, 11: 113-15(1969). (In Russian).

At 25°C and $\mu = 0.1$ the method of solubility was used to determine the stability constants of complexes of La, Y, and Th with trihydroxyglutaric acid at a 1:1 composition. Potentiometric titration using a glass electrode was used to determine the stability constants of complexes of La, Y, and Sc with trihydroxyglutaric acid. (tr-auth)

31329 PREPARATION AND COSUBLIMATION OF CYCLOPENTADIENYL DERIVATIVES OF PROMETHIUM AND ACTINIUM WITH PRASEODYMIUM CARRIER. Kopunec, R.; Macasek, F.; Mikulaj, V.; Drienovsky, P. (Comenius Univ., Bratislava). Radiochem. Radioanal. Lett., 1: 117-22(June 1969).

Further evidence for the existence of tris(cyclopentadienyl) promethium, as well as the first evidence for the related actinium compound, were obtained by co-sublimation of those radioelements with tris(cyclopentadienyl)praseodymium after action of cyclopentadienides, especially of $PrCp_3$ ($Cp = C_5H_5$), on the corresponding chlorides. (auth)

31330 EXCHANGE OF ^{239}PuIV BETWEEN TRANSFERRIN AND FERRITIN IN VITRO. Bruenger, F. W.; Stover, Betsy J.; Stevens, W.; Atherton, David R. (Univ. of Utah, Salt Lake City). Health Phys., 16: 339-40(Mar. 1969).

The transfer of ^{239}PuIV from transferrin, which is the transport protein for iron, to ferritin, which is a storage protein for iron, was investigated by gel filtration and gel electrophoresis. The results show that transport occurs in vitro at pH 8, and that under the specific conditions of the study the ferritin complex is more stable than the transferrin complex. (auth) (UK)

31331 TRAPPING OF HYDROGEN AND DEUTERIUM ATOMS PRODUCED BY THE PHOTOLYSIS OF HYDROGEN IODIDE IN 3-METHYLPENTANE-d_{14}. Timm, Dietrich; Willard, John E. (Univ. of Wisconsin, Madison). J. Amer. Chem. Soc., 91: 3406-7(June 4, 1969).

The ESR spectrum produced by the photolysis of HI in perdeuterated 3-methylpentane (3-MP) was studied in order to assist in determining whether the absence of ESR signals for H atoms in γ-irradiated solid hydrocarbons means that such atoms are not produced or simply that they are not trapped. Pronounced lines of the H doublet appeared after 60 sec of photolysis, or less, at all temperatures tested from 20 to 50°K. On further photolysis the two outer lines of the ^{2}H triplet appeared, the central line being obscured by the C_6D_{13} signal. Photolysis of HI in 3-MP-h_{14}, under conditions identical with those used with the 3-MP-d_{14} matrix, showed no evidence of the H doublet. (D.H.M.)

31332 ISOTOPE EFFECTS ON METASTABLE TRANSITIONS. III. CH_3CD_3 AND C_2H_6. Lifshitz, C.; Sternberg, R. (Hebrew Univ., Jerusalem). J. Mass Spectrom. Ion Phys., 2: 303-9(May 1969).

Metastable-ion intensities were determined at 70 eV for CH_3CD_3 and C_2H_6. There is no indication for a reshuffling of hydrogen atoms in the $CH_3CD_3^+$ ion, prior to molecular hydrogen elimination. An isotope effect is observed on both the intensity and kinetic energy release of the molecular hydrogen elimination from the parent. The results are discussed in view of recent electron impact experiments on isotopic methanes and methanols and the photoionization of ethane. (auth)

31333 STEREOCHEMICAL EQUILIBRIUM AND CONFIGURATIONAL STATISTICS IN POLYSTYRENE AND ITS OLIGOMERS. Williams, A. D.; Flory, P. J. (Stanford Univ., Calif.). J. Amer. Chem. Soc., 91: 3111-18(June 4, 1969).

Mixtures of diastereoisomers of 2,4,6-triphenylheptane (TPH) were epimerized in dimethyl sulfoxide (DMSO) containing t-BuOK. The mole fractions of isotactic, heterotactic, and syndiotactic isomers at equilibrium at 70°C are 0.217, 0.499, and 0.284, respectively. These results, in conjunction with the ratio 0.48/0.52 previously reported for the meso and racemic 2,4-diphenylpentanes (DPP) at equilibrium at 25°C, are interpreted according to the theory of stereochemical equilibrium. Proportions of various conformers in individual DPP and TPH isomers estimated from nmr coupling constants by Bovey and coworkers and by Pivcová and collaborators are interpreted similarly in terms of interactions associated with various conformations. The theory of equilibria between isomers and the associated theory of the conformer populations for each isomer provide a mutually consistent interpretation of the two kinds of results, the same arbitrary parameters (two in number) being used for both. Stereochemical equilibria and conformer populations calculated for polystyrene from the same parameters differ considerably from those for the oligomers. Deuterium exchange with the α-hydrogens in polystyrene were demonstrated by base catalysis in d_6-DMSO. (auth)

31334 THE KINETICS AND MECHANISM OF THE ACID-CATALYZED REARRANGEMENT OF 1-PHENYL-3-METHYL-ALLYL ALCOHOL AND THE HYDRATION OF 1-PHENYL-1,3-BUTADIENE. Pocker, Y.; Hill, Martin J. (Univ. of Washington, Seattle). J. Amer. Chem. Soc., 91: 3243-8(June 4, 1969).

The kinetics of the acid-catalyzed rearrangement, racemization, and ^{18}O exchange of 1-phenyl-3-methylallyl alcohol (1) were studied in 40% aqueous dioxane at 25.0°C. The three reaction rates were found to be identical in a given acid solution, and were further shown to be proportional to the acid concentration with the same second-order rate constant 6.8×10^{-2} l mole^{-1} sec^{-1}. The kinetics of racemization and ^{18}O exchange of 3-phenyl-1-methylallyl alcohol (2) were also studied and the rates shown to be the same within experimental error, with second-order rate constant 1.2×10^{-3} l mol^{-1} sec^{-1}. Finally, the rates of dehydration of 2 and hydration of 1-phenyl-1,3-butadiene (3) were followed and shown to correlate with the acidity of the medium, a plot of ln k vs. H_0 being linear with slope −1.49 in 40% dioxane and −1.22 in water. The mechanism of rearrangement of 1 thus involves protonation of 1 followed by unimolecular dissociation of the protonated species to form the intermediate carbonium ion, which is partitioned almost exclusively in favor of 2. The hydration of 3 proceeds via a rate-determining protonation of 3 to form the same carbonium ion, and the rate of dehydration of 2 is governed by the corresponding deprotonation of the carbonium ion. (auth)

31335 THE MECHANISM OF THE LIQUID-PHASE THERMAL DECOMPOSITION OF SOME DIALKYL OXALATES. Karabatsos, Gerasimos J.; Krumel, Karl L. (Michigan State Univ., East Lansing). J. Amer. Chem. Soc., 91: 3324-9(June 4, 1969).

The liquid-phase thermal decomposition of bis(cis-1,2-dimethylcyclopentyl) oxalate at 135°C gave a 92% yield of a hydrocarbon mixture, whose composition was 85% 1,2-dimethylcyclopentene and 15% 2,3-dimethylcyclopentene; that of the trans isomer gave an 83% yield, whose composition was 22% 1,2-dimethylcyclopentene, 75% 2,3-dimethylcyclopentene, and 3% 1-methylene-2-methylcyclopentane. The decompositions of bis(2,3,3-trimethyl-2-butyl-1,1,1-d_3) and bis(1-t-butylcyclohexyl) oxalates proceeded with 1,2-methyl migrations as evidenced by the formation of 14% 2,3,3-trimethyl-1-butene-4,4,4-d_3 and 6% isopropenyl-1-methylcyclohexane, respectively. The k_H/k_D isotope effect for the formation of isobutenes from the decomposition at 170°C of bis(2-methyl-2-propyl-1,1,1,3,3,3-d_6) oxalate and for the formation of trimethylbutenes from the decomposition at 160° of the bis(2,3,3-trimethyl-2-butyl-1,1,1-d_3) oxalate was 1.8. The isotope effect for the formation of 2-methyl-2-butenes from the decomposition of bis(2-methyl-2-pentyl-3-d) oxalate at 145°C was 1.6. All oxalates with deuterium atoms at the α-carbons decomposed more slowly than the corresponding unlabeled analogs. Bis(erythro-1,2-diphenylethyl-2-d) oxalate gave a 56% mixture of 95% trans-stilbene and 5% cis-stilbene. The trans-stilbene was about 90% d_1 and 10% d_0. The trans-stilbene from the corresponding threo compound was about 10% d_1 and 90% d_0. No 1,2-diphenylethanes were detected. Bis(exo-2-norboryl) oxalate decomposed at 250° to give a hydrocarbon mixture whose composition was 95% norbornane and 5% nortricyclene. The composition of the corresponding mixture from the decomposition at 280° of the endo compound was 33% norbornane and 67% nortricyclene. Bis[2-(Δ^3-cyclopentenyl)ethyl] oxalate decomposed at 320 to 350°C to give a hydrocarbon mixture of 3% norbornane, 70% nortricyclene, and 27% Δ^3-cyclopentenylethene. No norbornane was detected from any of the three decompositions. The data were interpreted in terms of an ion-pair intermediate, whose collapse to give olefins is about five to ten times faster than its internal reorientation in terms of the spacial relationship of the anion with respect to the cation. The thermal decomposition of bis(cyclopentylcarbinyl) oxalate at 360°C yielded a 30% mixture of hydrocarbons, whose composition was 52.5% methylenecyclopentane, 17.5% 1-methylcyclopentene, 5.3% cyclohexene, and 24.7% methylcyclopentane. Several other dialkyl oxalates of primary and secondary acyclic alcohols were found to decompose slowly at temperatures above 350°C. (auth)

31336 ^{14}C ISOTOPE EFFECTS IN THE ACETOLYSIS OF 2-ARYL-(ARYL-1-^{14}C)-ETHYL p-NITROBENZENESULFONATES. Yukawa, Yasuhide; Ando, Takashi; Token, Katsuo; Kawada, Mitsuru; Kim, Sueng-geon (Osaka Univ.). Tetrahedron Lett., No. 28, 2367-9(June 1969).

The primary ^{14}C isotope effects in the acetolysis of some phenyl-1-^{14}C-labeled 2-arylethyl esters were studied. Definite evidence of neighboring 4-methoxyphenyl (anisyl) participation in the transition state is presented. (P.C.H.)

31337 THE DECARBOXYLATION OF AZULENE-1-CARBOXYLIC ACID. II. ^{13}C ISOTOPE EFFECTS. Huang, H. H.; Long, F. A. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc., 91: 2872-5(May 21, 1969).

Carbon-13 isotope effects have been determined for the decarboxylation of azulene-1-carboxylic acid in aqueous solutions at 25° under two different sets of acidities. At acidities below 0.01 M C_{H^+}, where on the basis of previous studies the rate-determining step should be almost exclusively a slow proton transfer, virtually no ^{13}C isotope effect was observed. In contrast, at acidities of 0.3 M C_{H^+} an almost "full" isotope effect was observed, k_{12}/k_{13} being 1.035 in one series of experiments and 1.043 in a second. At this acidity the postulated mechanism and the rate parameters derived from it for this case indicated that about 90% of the reaction occurs by carbon-carbon bond rupture of a 1-protonated ampholyte, $AzH^+CO_2^-$, leading to carbon dioxide and the uncharged aromatic as products. This excellent agreement of the ^{13}C isotope effects, when combined with earlier evidence from kinetic behavior and deuterium solvent isotope effects, gives very strong support to the proposed mechanism. (auth)

31338 KINETIC ISOTOPE EFFECTS ON THE (2 + 2) CYCLOADDITIONS OF DIPHENYLKETENE WITH α- AND β-DEUTERIOSTYRENE. Baldwin, John E.; Kapecki, Jon A. (Univ. of Illinois, Urbana). J. Amer. Chem. Soc., 91: 3106-7(May 21, 1969).

Kinetic studies were made on the reactions between diphenylketene and mixtures of styrene with α-deuterio- or β,β-dideuteriostyrene. The kinetic isotope effect k_H/k_D at 65°C per deuterium at the β position of styrene determined through intermolecular competition experiments was 0.91 (an inverse effect) as expected; but k_H/k_D for substitution at the α position was 1.23. Data on the kinetic isotope effects determined in a series of runs are tabulated. The large isotope effects imply a significant progress toward bond making at both α and β positions of styrene in the rate-determining activated complex. (P.C.H.)

31339 MEASUREMENT OF CHLORINE ISOTOPIC EXCHANGE BETWEEN CHLORINE-SUBSTITUTED AROMATIC COMPOUNDS AND LITHIUM CHLORIDE. Gore, P. H.; Hammond, S. D.; Morris, D. F. C. (Brunel Univ., London). Radiochem. Radioanal. Lett., 1: 3-9(May 1969).

Experimental details of procedures used for studying ^{36}Cl exchange between chlorine-substituted aromatic compounds and lithium chloride labeled with chlorine-36 in stable homogeneous systems are described. (auth)

31340 CORRELATION BETWEEN STRUCTURE AND MECHANISM IN SOME IODINE EXCHANGE REACTIONS. Koeroes, E.; Orban, M. (L. Eoetvoes Univ., Budapest). Radiochem. Radioanal. Lett., 1: 87-91(May 1969).

The effects of structure on the mechanism of iodine exchange between elementary iodine and some iodopyrazolone derivatives and the role of donor site in the vicinity of the exchangeable atom are discussed. (auth)

31341 KINETICS OF IODINE EXCHANGE BETWEEN 1-PHENYL-2,3-DIMETHYL-4-IODOACETYLPYRAZOLONE AND IODIDE ION IN ETHANOL–WATER MIXTURES. Koeroes, E.; Orban, M.; Bedo, Zs. (L. Eoetvoes Univ., Budapest). Radiochem. Radioanal. Lett., 1: 93-8(May 1969).

The kinetics of the iodine exchange reaction between iodide ion and IAcpyr indexed as 4-(iodoacetyl)antipyrine, and the influence of the dielectric constants of the media on the reaction rate was studied in ethanol and in ethanol–water mixtures. The rate equation can be described by the expression $v = k\,[I^-]\,[Acpyr]$. The figures for the activation energy vary between 11.6 and 12.6 kcal/mole^{-1}, and for the activation entropy between −21 and 27.0 cal/mole^{-1} deg^{-1}. The Laidler–Eyring equation was applicable. (auth)

31342 THE CHEMICAL EQUILIBRIA OF FISSION-PRODUCT–NUCLEAR FUEL MIXTURES: THE URANIUM–OXYGEN AND THE URANIUM–OXYGEN–STRONTIUM SYSTEM. Fontana, Mario Herbert. Lafayette, Ind., Purdue Univ., 1968. 292p. Thesis.

Methods of using multicomponent chemical equilibrium computer techniques were developed for computing the chemical equilibria in the gas phase around a melted fuel element, and they were tested against published Knudsen cell-mass spectrometer data for the U–O system. This served as a base point from which the U–Sr–O system was extended. It was found that for the U–O systems, the gas phase composition (i.e., the partial pressures of U, O_2, UO, UO_2, and UO_3) could be predicted as a function of the O/U ratio in the solid phase, given the equilibrium constants of formation of the compounds of interest and the experimentally determined total pressure and atom ratios in the gas phase. The U–Sr–O system was estimated by relating the chemical species in the gas phase (U, O_2, UO, UO_2, UO_3, Sr, and SrO) to a computed equilibrium composition of the same species in the condensed phase. The effect of excess oxygen pressure, variation in activity coefficients, variability in the thermodynamic properties, and changes in O/U (solid) ratios were investigated. This analysis shows that the total amount of Sr in the gas phase

is most highly affected by the O:U ratio in the solid, the equilibrium constant of formation of SrO, and the activity coefficient of Sr. Reducing conditions enhance the total amount of Sr in the gas phase, as confirmed by independent experimental data on fission product release. Computer programs were written to generate tables of thermodynamic data needed by the equilibrium computer programs since complete tables of data are not available for most of the compounds of interest to nuclear safety. Experimental measurements of the vapor pressures of the compounds of interest above a condensed phase having well characterized atom ratios are necessary to give the non-ideality factors needed to extend this work to practical engineering calculations. (Disser. Abstr.)

31343 STUDY OF THE SOLUBILITY OF ZIRCONIUM OXIDE. Popa, Lucretia; Arsenie, Ioana (Institut de Physique Atomique, Bucharest). Rev. Roum. Chim., 14: 217-23(Feb. 1969). (In Rumanian).

Zirconium oxide is practically insoluble in hydrochloric and nitric acids and in their mixtures as well as in concentrated alkaline solutions and is partially soluble (2.2%) in 65% sulfuric acid and in concentrated solutions of sodium acid sulfate and potassium acid sulfate. The solubility is approximately 17.4% of the initial oxide. In 98% sulfuric acid the solubility is practically complete (98% of the initial oxide). By fusing zirconium oxide with sodium acid sulfate, or with sodium or potassium carbonate, total solubility is obtained according to the following relation (by weight): melt/zirconium oxide = (25 to 30)/1. The dissolution by fusion is rapid (20 min) so it is preferred to dissolution by the wet method in concentrated sulfuric acid, which is a procedure of long duration. (tr-auth)

31344 ATOMIC TRANSPORT AND ISOTOPIC MASS EFFECTS IN CLASSICAL LIQUIDS. Brown, R. C.; March, N. H. (Univ. of Sheffield, Eng.). Phys. Chem. Liquids, 1: 141-58(1968).

In classical liquids differing only in their isotopic mass M, with a total potential energy function independent of mass, the van Hove function $S(k, \omega, M, T)$ is shown to have the form $M^{\frac{1}{2}}f(k, \omega M^{\frac{1}{2}}, T)$, where f is the same function for different isotopes. This result applies also to the self part S_s $(k\omega)$ and combined with the Kubo formula for the coefficient of self-diffusion D, it follows that D is rigorously proportional to $M^{-\frac{1}{2}}$ in this theory. From the corresponding correlation function expressions for the shear and bulk viscosities, η and ζ, respectively, it is found that these are both proportional to $M^{\frac{1}{2}}$, a result obtained earlier on dimensional grounds by Rowlinson. It is argued in liquid metals, from the machine calculations of Paskin and Rahman, that the frequency spectrum has a rather well-defined range, essentially up to the Debye frequency ω_d. First-order formulas, consistent with the isotopic mass dependence discussed above, are then obtained for diffusion and viscosity of liquid metals at the melting point. An interesting feature of the formula for viscosity is its explicit dependence on the long wavelength limit of the liquid structure factor. A more general argument is also presented, which leads to similar results for diffusion and viscosity even when the Debye edge is badly blurred, as in Ar. Shear viscosity measurements for ^{6}Li and ^{7}Li deviate appreciably from the predictions of the classical theory. Measurements of the frequency spectra of light isotopes may help in clarifying the situation. Another possibility might be to study neutron scattering from a binary isotopic mixture, the theory of which is discussed in an appendix. (BBB)

31345 THE POLAROGRAPHIC BEHAVIOR OF URANIUM COMPOUNDS IN PROPANEDIOL-1,2-CARBONATE AND N,N-DIMETHYLACETAMIDE. Bildstein, H.; Fleischer, H.; Gutmann, V. (Oesterreichischen Studiengesellschaft fuer Atomenergie, Vienna). Inorg. Chim. Acta., 2: 347-50(Dec. 1968).

The polarographic behavior of anhydrous and hydrated U(IV) and uranyl compounds was investigated in propanediol-1,2-carbonate and in N,N-dimethylacetamide. The position of the half-wave potentials (vs aqueous saturated calomel electrode at 25°), the nature of the limiting currents, their dependency on the temperature and on the concentrations, the reversibility or irreversibility of the electrode reactions, the analytical applicability, and the influence of water are described in 0.1M solutions of tetraethylammonium-perchlorate. Uranyl ions are reduced in a 1-electron transition to U(V) : $UO_2^{2+} + e \rightarrow UO_2^{+}$. The half-wave potentials in different solvents depend on the donor number of solvent. High concentration and prolonged standing of the solutions caused changes in the polarograms of U(IV) chloride and of uranyl compounds in both solvents probably due to reaction of the dissolved salts with the solvent. (BBB)

31346 THE EFFECT OF DEUTERIUM OXIDE ON THE FLUORESCENCE OF REDUCED NICOTINAMIDE ADENINE DINUCLEOTIDE FREE IN SOLUTION AND IN COMPLEXES WITH LIVER ALCOHOL DEHYDROGENASE. Blomquist, Charles H. (Los Alamos Scientific Lab., N. Mex.). J. Biol. Chem., 244: 1605-7(Mar. 25, 1969).

The fluorescence emission intensity at 460 nm of reduced nicotinamide adenine dinucleotide (NADH) in solution is increased in the presence of D_2O over that observed in H_2O. The increase in fluorescence intensity is a linear function of D_2O concentration, and in 75 vol % D_2O equals 20%. A similar increase was observed with N-methyldihydronicotinamide, reduced 3-acetylpyridine adenine dinucleotide, and phosphodiesterase-hydrolyzed NADH. The D_2O perturbation of NADH fluorescence is reduced in binary complexes of NADH-alcohol dehydrogenase and in ternary complexes of NADH-alcohol dehydrogenase inhibitor. The D_2O enhancement of the fluorescence of chromophores containing proton donor groups can be explained on the basis of a kinetic isotope effect on proton transfer reactions in the excited state. The results indicate that the altered sensitivity of the bound coenzyme to D_2O results from an interaction of the nicotinamide moiety with the enzyme protein and is not simply the result of unfolding of the coenzyme molecule with complex formation. These interactions occur in the binary complex and further changes in solvent sensitivity of the bound coenzyme with ternary complex formation are at the limit of resolution of the method. (BBB)

31347 ISOTOPIC EXCHANGE REACTIONS INDUCED BY ALPHA PARTICLES IN HYDROGEN AND IN NITROGEN GASES. Mahoney, John Arthur. Princeton, N. J., Princeton Univ., 1968. 132p.

Thesis.

The steady-state treatment of radiolytic chain reactions gives rise to a nonlinear differential equation if there is a competition between second-order volume recombination and first-order wall termination. The equation was solved analytically for several limiting cases and numerically for spherical geometry. The numerical solution indicates that the reaction yield may be remarkably insensitive to either dose rate or pressure for many situations. An experimental study of the $H_2 + D_2 \rightarrow 2HD$ reaction induced by α particles apparently represents the first systematic investigation of the pressure dependence of the reaction yield. 2.75% Xe was added to suppress ion chain carriers and permitted isolation of the atom-molecule chain reaction. The results were in excellent agreement with predictions of the solution of the diffusion equation and permitted a determination of the efficiency of radiolytic production of H atoms: $G_H = 7.2 \pm 0.8$ atoms/100 eV deposited. Experiments with the $^{14}N_2 + {}^{15}N_2 \rightarrow 2{}^{14}N{}^{15}N$ system gave a value for G_X, the radiolytic efficiency for the exchange reaction, of 7.8 ± 0.5 exchanges/100 eV deposited in equimolar mixtures of the isotopes. G_X was materially reduced when nonequimolar mixtures were irradiated. Although the yields in nitrogen were independent of total pressure, comparisons with the solutions of the diffusion equation show that the existence of a chain reaction is not excluded. (Disser. Abstr.)

31348 PROBLEMS IN METAL-N-SUBSTITUTED AMINE COMPLEXES. Conklin, Dennis Peter. New York, Fordham Univ., 1968. 156p.

Thesis.

By means of solid-solid interaction, complexes of uranyl nitrate with various N-alkyl substituted urea ligands were prepared, with determination of the coordination number of the uranyl ion as the primary objective. In each of the fourteen complexes of uranyl nitrate with N-alkylurea ligands isolated, chemical analysis, infrared spectral data, and x-ray powder diffraction patterns were utilized to confirm individuality and purity. Although isolation of the complexes of the series $[UO_2(NO_3)_2(ligand)_2]$, (ligand = 1-methylurea, 1,1-dimethylurea, 1,3-dimethylurea, 1-ethylurea, 1,3-diethylurea, 1-propylurea, and 1-butylurea) was successful, only one modification was found for each case. Furthermore, only two complexes of the type $[UO_2(NO_3)(ligand)_3]NO_3$, (ligand = 1-MU and 1-EU), and five of the series $[UO_2(ligand)_5](NO_3)_2$, (ligand = 1-MU, 1,1-DMU, 1,3-DMU, 1-EU, and 1,3-DEU) have been isolated. Apparently the number and size of the alkyl groups plus the number of NO_3^- groups in the coordination sphere of the uranyl ion are two strongly influential factors on complex formation. Infrared spectral data indicated that in all fourteen complexes isolated, the ligand is bonded to the U atom of the uranyl ion through the carbonyl oxygen. Infrared spectra also indicated that in the series $[UO_2(NO_3)_2(ligand)_2]$, the NO_3^- groups are both covalent, while in $[UO_2(NO_3)(ligand)_3]NO_3$, one NO_3^- group is covalent and the second ionic, and, finally, the NO_3^- groups in $[UO_2(ligand)_5](NO_3)_2$ are both ionic. Furthermore, previous single-crystal x-ray structural data have shown the uranyl ion in $[UO_2(NO_3)_2(H_2O)_2] \cdot 4H_2O$ to be six-coordinated, whereas it is five-coordinated in the complex $[UO_2(urea)_4(H_2O)](NO_3)_2$. The previously discussed infrared data plus the two crystal structures cited above lead to the conclusions that in the series $[UO_2(NO_3)_2(ligand)_2]$, the uranyl ion is six-coordinated, whereas in both $[UO_2(NO_3)(ligand)_3]NO_3$ and $[UO_2(ligand)_5](NO_3)_2$, the uranyl ion is five-coordinated. In order to verify the N bonding in the cyano

group as well as to confirm the geometrical configuration, the single-crystal x-ray structure of the reported cis-diisocyanotriethylenetetramine cobalt(III) perchlorate was investigated. The density of the crystal was found to be 1.62 g/ml, four molecules per unit cell were found for the space group $P2_1/c$. Multiple-film equi-inclination Weissenberg photographs on layers h0l–h5l were cross-correlated with precession data on the zones 0kl and hk0. By means of Patterson–Fourier syntheses and full-matrix least-square refinement techniques, a final value of the residual, R′, of 8.8% was obtained. It was found, however, that the cyanides were trans to one another, and also were carbon rather than nitrogen bonded. Ring strain of a trans configuration for octahedral triethylenetetramine complexes has been verified, with the equatorial trien ring being both non-planar and "opened" from a square configuration. Bond distances and bond angles were all approximately normal. The asymmetric unit chosen for study has an l or RR configuration with respect to the trien group in the cation, $[Co(trien)(CN)_2]^+$. Since four molecules per unit cell were found, and since the space group $P2_1/c$ has a center of inversion, each l or RR cation has an inverted "partner" with a D or SS configuration. Hence, the entire crystal consists of an equimolar racemic mixture of d-SS and l-RR forms of $[Co(trien)(CN)_2]ClO_4$. (Disser. Abstr.)

31349 VIBRATIONAL FREQUENCIES OF DEUTERATED ETHYLENES: GREEN'S FUNCTION METHOD. Ramaswamy, K.; Devarajan, V. (Annamalai Univ., Annamalainagar, India). Aust. J. Chem., 22: 299-303(Feb. 1969).

The frequencies of the partly deuterated ethylenes were predicted by the method of Green's function analysis. These values are compared with those obtained by the average rule and complete rule. A table lists the frequencies of C_2H_4 and C_2D_4 from which the mixing parameter matrix A elements were calculated. In another table the frequency values of the deuterated ethylenes are given along with the values calculated by the average rule and the complete isotope rule. It was seen that the values calculated from Green's function method agreed fairly well with the experimental values except in the case of some bending frequencies. In some cases these values agreed with the observed values better than the average-rule values. The large differences in certain values may be attributed to the approximation in the ΔG matrix. It was concluded that Green's function analysis gives a better insight into the isotopic rule from the molecular dynamic point of view. (BBB)

31350 ESR STUDIES OF FREE RADICALS FORMED IN POLYAMINO ACIDS BY REACTIONS WITH H ATOMS. Liming, Franklin Glenn Jr. Durham, N. C., Duke Univ., 1968. 123p. Thesis.

Free radicals produced by reaction of gaseous H atoms with powdered samples of polyamino acids were investigated through their electron spin resonance (ESR). Samples were exposed to H atoms and examined under vacuum in an x-band spectrometer at both 77°K and 300°K. Other samples were exposed to the 1.3 MeV γ rays from a ^{60}Co source. In most instances the ESR signals observed after exposure to H atoms were similar to those produced by γ radiation. The polypeptide backbone is broken at the C_α–N bond in poly-L-alanine and poly-L-valine, and the five-membered ring is broken in poly-L-proline at the C–N bond next to the polypeptide backbone. An H atom is removed from C_α on the polypeptide backbone in poly-glycine, poly-L-aspartic acid, poly-L-glutamic acid, and poly-L-hydroxyproline; an H atom is removed from the end of the side group of poly-DL-leucine. The CH_3 group is removed from poly-L-methionine. H atoms add to the conjugated rings of poly-L-phenylalanine, poly-L-tyrosine, poly-DL-tryptophan, and poly-L-histidine. The radicals formed in poly-L-serine, poly-L-lysine HBr, and poly-S-benzyl-L-cysteine can not be definitely assigned, but the spectra of these three compounds all have a doublet splitting of 16 to 20 G. Molecular orbital theory was used to calculate the spin density distribution of the unpaired electron in the postulated radicals for the polyamino acids with conjugated side groups. The theoretical coupling constants calculated from these spin densities agree very well with the experimental coupling constants. The H atoms add to the meta positions of both poly-L-phenylalanine and poly-L-tyrosine. In poly-DL-tryptophan the H atoms add to C_7 of the indole group. Two random copolymers of amino acids were exposed to H atoms in order to find out which of two amino acid side groups is the more likely site of reaction with H atoms. The 1:1 copolymer of L-alanine and L-tyrosine produces the same spectrum as a sample of poly-L-tyrosine. The tyrosine group absorbs the H atoms and protects the rest of the molecule. The 1:1.9 copolymer of glycine and L-proline also forms only one type of radical: the same radical observed in poly-L-proline. The results of this study show the possible types of reactions between proteins and H atoms. The data from the random copolymers provide the first clues as to which amino acid side groups in the proteins are the most reactive toward H atoms. (Disser. Abstr.)

31351 ENZYMATIC REACTIONS IN TRITIATED WATER. IV. APPARENT NULLIFICATION OF ENZYMATIC TRITIUM TRANSFER BY MEANS OF NAD. Wenzel, Martin; Bruehmueller, Margarete (Freie Univ., Berlin). Z. Physiol. Chem., 348: 1387-91(Nov. 1967). (In German).

Transfer of T (or D) enzymatically via NAD (nicotinamide adenine dinucleotide) was previously observed only with substrates whose dehydrogenases both have the same stereospecificity, i.e., either type A only or type B only. However, it is shown that T transfer is possible even with two dehydrogenases possessing opposite stereospecificity, if the concentration of coenzyme is low. With 2-T-glutamate and pyruvate (or oxaloacetate) as substrates and glutamate dehydrogenase (type B) and lactate dehydrogenase (type A) as enzymes, 2-T-lactate (or 2-T-malate) was obtained. Since 2-T-glutamate may be produced by enzymatic reactions in tritiated water and the tritium transferred to further substrates, the results are discussed with reference to the danger of T incorporation from tritiated water. (BBB)

31352 THE DEPENDENCE OF KINETIC ISOTOPE EFFECTS ON THE FREE ENERGY CHANGE FOR PROTON TRANSFER REACTIONS. Matthews, D. B. (Union Carbide Australia Ltd., Rhodes). Aust. J. Chem., 22: 463-4(Feb. 1969).

In the use of kinetic isotope effects for determination of the mechanism of proton transfer reactions, the role played by 3 factors is considered, namely, the bending modes of the activated state, the "symmetric" stretching mode of the activated state, and proton tunneling (or, the asymmetric stretching mode of the activated state). It was shown earlier that, under certain conditions, the contributions of proton tunneling and of the "symmetric" stretching mode may cancel, which thus implicates the bending mode as the controlling factor in kinetic isotope effects. It is now shown that this alleged cancellation does not have general validity, and that it occurs only under special circumstances. The basis for this claim lies in the fact that both factors are dependent on the electromechanical free energy change of the proton transfer step and that, while the sign of the dependence is identical, one factor tends to increase the magnitude of the isotope effect while the other tends to decrease it. It is shown that for proton tunneling the correction to the kinetic isotope effect is unity for large positive free energies of reaction, ΔG_0, increases with decrease in ΔG_0, going through a maximum at $\Delta G_0 = 0$, and decreases towards unity for large negative values at ΔG_0. (BBB)

31353 VINYL ETHER HYDROLYSIS. SPECIFIC ACID CATALYZED HYDROLYSIS OF 4-METHOXY-3-BUTEN-2-ONE. Fedor, Leo R.; McLaughlin, John (State Univ. of New York, Buffalo). J. Amer. Chem. Soc., 91: 3594-7(June 18, 1969).

The hydrolysis of 4-methoxy-3-buten-2-one (1) to 3-ketobutanal in aqueous solution is specific acid catalyzed and is further characterized by $k_2(D_2O)/k_2(H_2O) = 2.08$ and $\Delta S^\ddagger = -26.0 \pm 1.7$ eu. These results are consonant with an A2 mechanism involving rate-determining hydrolysis of the conjugate acid of 1. (auth)

31354 INVESTIGATION OF POTASSIUM PENTAFLUOROURANYLATE BY INFRARED SPECTROSCOPY. Kharitonov, Yu. Ya.; Knyazeva, N. A.; Buslaev, Yu. A. Zh. Neorg. Khim., 14: 1034-9(Apr. 1969). (In Russian).

The absorption spectra (140 to 4000 cm^{-1}) of $K_3U^{16}O_2F_5$ and mixtures of $K_3U^{16}O_2F_5$–$K_3U^{16}O^{18}OF_5$–$K_3U^{18}O_2F_5$ were studied. The power constants, which enter in secular equation of the type $A_2^1(D_{5h})$, were calculated. (tr-auth)

31355 COMPLEXES OF URANIUM(VI) AND MOLYBDENUM (VI) WITH TRIHYDROXYGLUTARIC ACID. Vorob'ev, S. P.; Davydov, I. P.; Shilin, I. V. Zh. Neorg. Khim., 14: 1029-33(Apr. 1969). (In Russian).

The formation constants for the complexes of UO_2^{2+} and MoO_2^{2+} with trihydroxyglutaric acid were determined in acid solutions by spectrophotometry. The values obtained at $\mu = 2$ were for UO_2^{2+} $\beta_1 = 2.0 \pm 0.2$; $\beta_2 = 2.9 \pm 0.2$; and for MoO_2^{2+} $\beta_1 = 142 \pm 20$; $\beta_2 = 3470 \pm 300$. The mole ratios of the complexes were found to be 1:1 and 1:2 depending on the concentration of trihydroxyglutaric acid and hydrogen ions. (tr-auth)

31356 VIBRATIONAL SPECTRA AND STRUCTURE OF FOUR-MEMBERED RING MOLECULES. XIV. VIBRATIONAL ANALYSIS AND RING PUCKERING VIBRATION OF TRIMETHYLENE SELENIDE AND TRIMETHYLENE SELENIDE-d_4. Harvey, A. B. (Naval Research Lab., Washington, D. C.); Durig, J. R.; Morrissey, A. C. J. Chem. Phys., 50: 4949-61(June 1, 1969).

The infrared and Raman spectra of trimethylene selenide (TMSe) and trimethylene selenide-2,2,4,4-d_4 (TMSe-d_4) were recorded from 4000 to 15 cm^{-1} in gaseous, liquid, and solid states. A vibrational assignment of the fundamentals is consistent with the expected C_s equilibrium configuration. A series of sharp bands

associated with the ring puckering vibration were observed in the mid- and far-infrared regions. The frequencies of the transitions were employed in determining the following double-minimum potential, barrier-to-ring inversion, and the equilibrium separation of the ring diagonal, 2x in angstroms, for TMSe, respectively: V (cm^{-1}) = 4.258 (±0.02) × 10^5x^4 − 2.5391 (±0.007) × 10^4x^2; 378.1 ± 4 cm^{-1}; 0.35 Å. For TMSe-d_6 these quantities are: V (cm^{-1}) = 3.242 (±0.1) × 10^5x^4 − 2.208 (±0.033) × 10^4x^2; 375 ± 10 cm^{-1}; 0.37 Å, respectively. The dihedral angle of both molecules is calculated to be 32.5 ± 2°C. (auth)

31357 LACK OF COMPLEXING BETWEEN U^{4+} AND NO_3^- IN AQUEOUS SOLUTIONS. Solovkin, A. S. Zh. Neorg. Khim., 14: 1124-6(Apr. 1969). (In Russian).

Theoretical and experimental data are tabulated for estimating the physical and chemical incompatibility of the $U^{4+}-ClO_4^--NO_3^--H_2O$ system and the non-complexing of U^{4+} and NO_3^- in aqueous solutions was discussed. (R.V.J.)

Radiation and Nuclear Chemistry

Refer also to abstracts 31350, 31478, 31643, and 32949.

31358 (CEA-R-3537) APPLICATIONS OF ELECTRON SPIN RESONANCE TO SOME PROBLEMS OF RADIATION CHEMISTRY. Chachaty, Claude (Commissariat a l'Energie Atomique Saclay (France). Centre d Etudes Nucleaires). Mar. 1969. 110p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

The electron spin resonance (ESR) spectra of γ-irradiated polar organic glasses, at 77°K, shows a single line centered at g ≃ 2, attributed to solvated electrons. The radicals produced on scavenging this species by electron acceptors, such as aromatic hydrocarbons, nitro compounds and azines were studied by ESR. In most cases, the radicals from these solutes, the spectra of which are observed after elimination by warming of the radicals from the matrices, are produced by protonation of the anions formed by scavenging of electrons at 77°K. Thus, in the case of glassy solutions of nitro compounds, the radicals R NO_2H are formed. They are characterized by a_N = 15 G (nitrobenzene) or a_N = 28 G (nitroalkane). These radicals are also generated by uv photolysis at room temperature of solutions of nitro compounds in alcohols and are shown to be the precursors of nitroxide radicals $R-\underset{\underset{O\cdot}{|}}{N}-R$ observed simultaneously. Gamma irradiation of solutions of pyridine and of the three diazines, in alcohol glasses at 77°K, produces the radical formed by hydrogen addition to these compounds. The value of the coupling constant of the additional proton (7 to 10 G) indicates that it is bound to a nitrogen in the sp^2 hybridation state. It is shown, taking pyridine as an example, that the addition to a carbon gives a much greater value of the coupling constant, of the order of 50 to 60 G. (auth)

31359 (CONF-681032-, pp 11-21) DISCOVERY AND HISTORY OF ^{252}Cf. Fields, Paul R. (Argonne National Lab., Ill.).

The production of ^{252}Cf from the capture of 13 successive neutrons by ^{239}Pu in a reactor and in a thermonuclear explosion is described. (M.C.G.)

31360 (CONF-681032-, pp 151-7) PRODUCTION OF ^{252}Cf IN THERMONUCLEAR EXPLOSIONS. Cowan, George A. (Los Alamos Scientific Lab., N. Mex.).

Relative economics of fission reactor methods and the thermonuclear explosion method for the synthesis of ^{252}Cf are considered. The initial target material in both cases is ^{238}U. The nuclear reactions in the production processes and economic aspects of the thermonuclear method are discussed. (M.C.G.)

31361 (CONF-681032-, pp 159-77) ^{252}Cf PRODUCTION AT OAK RIDGE NATIONAL LABORATORY. Bigelow, John Ealy (Oak Ridge National Lab., Tenn.).

The High Flux Isotope Reactor (HFIR) and the Transuranium Processing (TRU) Plant are described. The TRU flow sheet for purification of the transplutonium elements produced in the HFIR is described. The Tramex process and a LiCl anion-exchange method are used. (M.C.G.)

31362 (CONF-681032-, pp 179-200) LARGE-SCALE PRODUCTION OF ^{252}Cf: REACTOR IRRADIATION, CHEMICAL RECOVERY, AND SOURCE FABRICATION. Smith, J. A. (Du Pont de Nemours (E. I) and Co., Aiken, S. C. Savannah River Lab.).

In response to current indications of possible large-scale applications of ^{252}Cf, Savannah River proposed a two-phase production program; make 2 to 3 grams for development of applications and provide kilograms per year for applications. The gram quantities can be made by irradiation of plutonium–americium–curium (residues from a ^{244}Cm production program) at a thermal flux of about 10^{15} n/(cm^2)(sec), isolation of californium by solvent-extraction and ion-exchange-chromatography processes, fabrication of sources in some prescribed geometry (e.g., wires, disks, pellets), and encapsulation of sources in suitable material. Production of kg/yr is contingent upon supply of hundreds of kg/yr of ^{243}Am from power reactors and successful development of a reactor core designed for greater capacity of starting material and lower losses to fission between ^{243}Am and ^{252}Cf, relative to thermal reactors. Known alternative sources of supply and reactor design would produce californium at lower rates. (auth)

31363 (CONF-681032-, pp 201-11) DEVELOPMENT AND PRODUCTION OF ^{252}Cf. Baranowski, Frank P. (Division of Production (AEC), Washington, D. C.).

Plans for production of ^{252}Cf are considered and their economic aspects discussed. An AEC program for loan of californium-252 neutron sources for research on applications is described. Forecasts of quantities of material, timing, and prices are provided. (M.C.G.)

31364 (CONF-681056-1) CHEMICAL ASPECTS OF APPLICATIONS OF RADIATION. Cramer, W. A. (Reactor Instituut Delft (Netherlands)). [1968]. 5p. (In Dutch). (RI-133-68-16). Dep.

From Conference on Industrial Applications of Radiation Techniques, Utrecht, Netherlands.

31365 (EUR-4233) ELECTRON SPIN RESONANCE STUDIES ON RADICALS PRODUCED FROM ORGANIC INCLUSION COMPOUNDS BY ELECTRON BOMBARDMENT. Juppe, G.; Fantechi, R.; Helcke, G. A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 12, 1968. 36p. (In German). Dep.

The radiolysis of unsubstituted and methyl-substituted aromatic compounds is discussed with regard to intermediate formation of radicals, their structure and reactivity, and the possibility of their observation with electron spin resonance methods. A method is described that makes possible the observation of well-resolved electron spin resonance spectra from short-lived radicals produced during fast electron irradiation of inclusion compounds of organic molecules. This technique has the advantage that substances whose liquids have a dielectric absorption in the microwave region can be studied at temperatures well above their freezing points. Irradiation of ethyl ether absorbed in a molecular sieve gave a well-resolved spectrum of the ethyl radical at +150°C and irradiation of cyclohexane as a thiourea adduct gave the spectrum of the cyclohexyl radical at room temperature. The observation of the benzyl radical during the irradiation of toluene adsorbed in a molecular sieve at −30°C is also described. (auth)

31366 (NP-tr-1786) EFFECTS OF X-RAYS ON DYE SOLUTIONS. Matsuzawa, Hideo; Nishino, Takuro; Musha, Kiyoshi; Hayakawa, Saburo; Akiyama, Masanori; Hirahara, Akira; Ichikawa, Kenji; Hayashi, Tatsuma. Translated by D. Jackson (Atomic Energy Research Establishment, Harwell, Eng.), from Kitakanto Igaku, 9: 568-75(1959). 10p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 15: 22340.

31367 HALF-LIFE MEASUREMENTS IN EMULSION POLYMERIZATION. Ley, Gregor J. M.; Schneider, Christel; Hummel, Dieter O. (Institut fuer Physikalische Chemie und Kolloidchemie, Cologne). J. Polym. Sci., Part C, No. 27, 119-37(1969).

From 152nd National Meeting of the American Chemical Society, New York. See CONF-660907.

Intermittent ^{60}Co γ radiation was used in a study of emulsion polymerization of styrene, methyl methacrylate, butyl methacrylate, methyl acrylate, ethyl acrylate, butyl acrylate, acrylonitrile, vinylidene chloride, vinyl acetate, and chloroprene. A sensitive recording dilatometer was used to follow the build-up and decay of polymerization rate and radical concentration. Reaction rate versus time curves of these emulsion systems with intermittent irradiation are given and the values of the apparent half-life times of the monomers were compared. Apparent half-life of the propagating radicals in emulsion ranged from below 1 min in the case of vinyl acetate up to about 80 min in the case of styrene. Variation of half-life of the styrene radical with conversion, temperature, monomer and emulsifier concentration, and transfer agents added was determined. Calculation of the apparent termination rate constant of styrene yielded values of about 1 × 10^3 l/mol-sec in emulsion as compared to literature data of about 1 × 10^7 l/mol-sec in homogeneous systems. (auth)

31368 TEMPERATURE EFFECTS ON THE FORMATION AND REACTIONS OF FREE RADICALS IN GAMMA-IRRADIATED DRY ENZYMES. Stratton, K. (Massachusetts General Hospital, Boston. Harvard Medical School, Boston). Radiat. Res., 35: 182-201(1968).

ESR spectra observed at 100°K after irradiation at 77°K, of those enzymes containing cystine residues were unsymmetrical, with an additional peak of G-value about 2.01, attributed to a sulfur radical. D-Amino acid oxidase, urease, alcohol dehydrogenase, and glyceraldehyde 3-phosphate dehydrogenase, and others which have SH groups, showed only minor evidence of this additional peak. Other enzymes such as invertase, galactosidase, and glucose oxidase, and the nucleoprotein histone, had nearly symmetrical spectra, generally with poorly resolved fine structure. After warming to 295°K, or after irradiation at 295°K, all substances had typical protein spectra with partially resolved doublets and some fine structure. Enzymes with S—S bonds also showed a strong —CH_2—S · radical spectrum, but SH-containing enzymes had insignificant sulfur spectra at 295°K. Samples irradiated at 77°K showed little loss of radicals on warming to 295°K, in spite of the spectral changes that occurred. Secondary radical yields measured at 295°K were up to 60% higher for irradiations at 295°K than for those at 77°K. This temperature variation is, however, appreciably less than reported variations of yields of inactivated molecules over the range 77 to 295°K. The results indicate that other processes in addition to reactions of stable secondary radicals must be responsible for a considerable fraction of radioinduced enzyme inactivations. (auth)

31369 FORMATION OF FREE RADICALS IN ALIPHATIC THIOLS AT 77°K UNDER THE ACTION OF γ-RAYS. Bichiashvili, A. D.; Nanobashvili, E. M.; Barsegov, R. G. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 337-40(Feb. 1969). (In Russian).

The γ radiolysis of n-alkanethiols $C_nH_{2n+1}SH$, where n = 2, 3, 4, 5, 6, 7, 12, 16, was investigated by the EPR method. The nature of primary radical products was established and their radiation yields measured. Efficiency of energy transfer along the hydrocarbon chain to the sulfhydryl group was estimated. (auth)

31370 PRODUCTS OF PARAFFIN RADIOLYSIS. Salovey, R.; Bair, H. E.; Luongo, J. P. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Polym. Sci., Part B, 7: 241-3(Apr. 1969).

Studies were made on the products from the radiolysis of n-hexatriacontane. The results showed that the main products, crosslinked and unsaturated molecules, were rejected by growing crystals during crystallization from solution and were concentrated in discrete phase. The yield of transtype unsaturation was apparently independent of physical state during irradiation. The complete separation of unsaturated products was contrasted with the partial rejection of crosslinked species and it was inferred that these are separate entities. (P.C.H.)

31371 MOLECULAR WEIGHT DISTRIBUTIONS IN RADIATION-INDUCED POLYMERIZATION. II. γ-RAY-INDUCED POLYMERIZATION OF STYRENE IN THE PRESENCE OF METHANOL. Huang, Robert Y. M.; Chandramouli, P. (Univ. of Waterloo, Ontario). J. Polym. Sci., Part B, 7: 245-9(Apr. 1969).

Studies were made on the molecular weight distributions of polystyrene from the γ-radioinduced polymerization of styrene in the presence of methanol using gel permeation chromatography (GPC). Preliminary results indicated that the molecular weight distributions are relatively narrow and that no trace of the Trommsdorf effect (C. G. Odian, et al., J. Polym. Sci., 55, 665 (1961)) could be observed at radiation intensities of 0.83×10^6 rads/hr. (P.C.H.)

31372 EFFECT OF THE FINE STRUCTURE OF CELLULOSE ON RADIATION-INDUCED GRAFT COPOLYMERISATION. Ahmed, Amin Uddin. Toronto, Univ. of Toronto, 1967. Thesis.

Radioinduced grafting of vinyl monomers, viz., styrene, ethyl acrylate, butyl methacrylate and dimethylaminoethyl methacrylate on different cellulosic materials was carried out using ^{60}Co gamma rays. It was found that the amount of grafting depended on the fine structure of cellulose as well as on other factors. The results indicate that more free radicals are found in the more ordered regions of cellulose on exposure to ionizing radiation, and that these regions become more accessible and hence grafting occurs in these regions as well. X-ray crystallinity and density decrease on irradiation, pointing to the production of a more "open" structure as a result of irradiation of cellulose. Charlesby's theory of the radioinduced degradation of cellulose is discussed and it is shown that his basic assumption of the constancy of the probability of the main chain fracture at a given monomer unit in the cellulose molecule per unit radiation dose is incorrect. Using osmometry to find the number average molecular weight of cellulose triacetate after different doses, it has been shown that the G-value for cleavage does not remain constant but decreases rapidly during the initial stages of irradiation. A much more drastic decrease (about 20 fold) in the $G_{(-glucose)}$ was estimated to take place during irradiation of crystalline glucose using data from the literature. Viscosity data on cotton linters, wood pulp, and rayon, which have different degrees of crystallinity, showed that the slopes of lines log $[\eta]$ against log $(R + R_0)$ were different and could not be used to calculate the $\bar{M}_v$ accurately. Electron paramagnetic resonance studies showed that $G_{(free\ radicals)}$ for crystalline cellulose was higher than that for amorphous cellulose. The higher the crystallinity of cellulose, the higher the value of the EPR spectroscopic splitting factor "g." The old ideas and present theories regarding the fine structure of cellulose are briefly discussed and a concept of fine structure of cellulose based on Manley's helical protofibril and the deuterium exchange data obtained in this investigation is proposed. The role of the protofibril in this model is analogous to the role of the individual molecule in the fringe micellar model. An attempt was also made to interpret some of the properties of cellulose on this model. The decrease in the accessibility of cellulose on acid hydrolysis is explained on the basis of preferential attack of the acid on the disordered regions, whereas the shrinkage in the length of rayon fibres on treatment with concentrated sodium hydroxide solution is explained on the basis of unwinding of helices, forming helices of larger diameter thereby shortening the length of the fibres. (Disser. Abstr.)

31373 ION RADICAL FORMATION FROM α-METHYLSTYRENE IN IRRADIATED ORGANIC GLASSES. Yoshida, Hiroshi (Kyoto Univ.); Hashimoto, Satoshi; Iwamoto, Takeo; Okamura, Seizo. Bull. Inst. Chem. Res., Kyoto Univ., 47: 1-7 (Jan. 1969).

In order to study the ionic reactions of α-methylstyrene induced by ionizing radiations, 2-methyltetrahydrofuran and n-butyl chloride glasses containing a small amount of α-methylstyrene were irradiated by ^{60}Co γ-rays at 77°K and studied by means of electron spin resonance. In the former glass, the electron transfer occurs from the irradiated glass matrix to the solute, α-methylstyrene, giving anion radicals of α-methylstyrene. In the latter glass, the positive charge transfer from the glass matrix to the solute occurs and the cation radicals are formed. The anion radicals give an unresolved spectrum with the width (peak-to-peak in derivative curve) of 14 Gauss, which is bleached readily by visible lights. The cation radicals give a spectrum with the width of 35 Gauss. The observed shape of the spectra is in good agreement with that expected from the molecular orbital calculation. (auth)

31374 THE RADIATION CHEMISTRY OF BIOCHEMICAL DISULFIDES. II. LIPOIC ACID. Owen, Terence C.; Wilbraham, Antony C. (Univ. of South Florida, Tampa). J. Amer. Chem. Soc., 91: 3365-71(June 4, 1969).

α-Lipoic acid (6-thiotic acid) is destroyed in high yield upon exposure to x rays in aerated or deaerated aqueous solution. Small amounts, only, of thiol and of oxidation products (sulfonic and sulfinic acid, etc.) and hydrogen peroxide are produced. The major product appears to be a cyclic dimer. A mechanism is presented which accommodates all of the experimental observations. Kinetic treatment of the mechanism affords it support and requires a linear increase in radiation-chemical yield with concentration such that $G_0(-\text{lipoate}) = 2(G_{OH} + G_H) + K[\text{lipoate}]$ at lipoate concentrations above 5 to 10 m$\underline{M}$. The radiobiological significance of the work is briefly discussed. (auth)

31375 CHEMICAL STRUCTURE OF POLY(VINYL ALCOHOL)-STYRENE GRAFT COPOLYMER PREPARED BY PRE-IRRADIATION TECHNIQUE. Sakurada, Ichiro; Ikada, Yoshito; Horii, Fumitaka (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 47: 58-66(Jan. 1969).

The chemical structure of poly(vinyl alcohol)–styrene (PVA–St) graft copolymer prepared by a preirradiation technique was studied by isolating the pure graft copolymer. After complete benzoylation of the PVA backbone of the graft copolymer, fractionation was carried out by fractional precipitation, and the chemical composition of each fraction was determined by ester exchange of the benzoyl groups in the graft copolymer. The grafted fraction branches were separated from the backbone by cleaving 1,2-glycol bonds in the PVA molecule, and osmotic pressure measurements were carried out for the fractionated graft copolymers and the separated branches after benzoylation of the PVA parts. By these measurements, it was possible to estimate the length of the backbone as well as of the branch. From the results it was concluded that the graft copolymer carried only one grafted branch, and that the backbone was formed from several mother PVA molecules which were crosslinked with each other. The molecular structure of this graft copolymer is quite similar to that of the PVA–MMA graft copolymer. The amount of PVA participating in the grafting reaction was found to be only 9.6%. (auth)

31376 OPTICAL AND EPR STUDIES ON IRRADIATED $CdCl_2$: Ag. Kanno, Keni-chi (Kyoto Univ.); Miyanaga, Takeshi;

Naoe, Shuni-chi; Matsumoto, Hiroaki. Bull. Inst. Chem. Res., Kyoto Univ., 47: 14-22(Jan. 1969).

An optical absorption band was found at 227 nm in the vicinity of the fundamental absorption edge of $CdCl_2$ crystal doped with a small amount of AgCl. There appeared some absorption bands near 397 nm and 515 nm with a decrease of the 227 nm band when irradiated with γ-rays of a neutron beam. Optical bleaching experiments showed that the 397 nm band decayed and the 227 nm band recovered when irradiated with 350 nm light. A paramagnetic center was also found in the study of the EPR spectra of the irradiated crystal. This paramagnetic center was identified with substitutional Ag^{++} ion with a tetragonally distorted environment in the crystal. The investigation revealed an isothermal decay process of the EPR and optical absorption bands and that the 397 nm absorption band corresponds to Ag^{++} paramagnetic center. The 397 nm band is due to the transition associated with the electron transfer from $t_{1u}(\sigma)$ orbital of distorted Cl^- ligands to b_g orbital of the central Ag^{++} ion. (auth)

31377 SELECTIVITY OF C–H BOND RUPTURE BY γ RADIOLYSIS AND HOT-RADICAL ATTACK IN SINGLY BRANCHED ALKANE GLASSES. Henderson, Don J.; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Amer. Chem. Soc., 91: 3014-20(May 21, 1969).

Trapped free radicals are produced in singly branched alkane glasses at 77°K by γ irradiation, hot-radical attack, or photosensitization by aromatic solutes. In contrast to similar activation in the gas and liquid phases, there is a high selectivity for rupture of a particular type of secondary C–H bond, as indicated by the ESR spectra of the resultant free radicals. All three methods of activation show the same selectivity. For molecules with branching in the 3 or 4 position, the free radicals formed result predominantly from loss of a hydrogen atom from the secondary carbon atom nearest the end of the longest carbon chain. When branching is in the 2 position, detectable amounts of the radical resulting from loss of a tertiary hydrogen are also found. Identification of the trapped radical formed from 3-methylpentane glass has been made by comparing its ESR spectrum with the spectra of the four possible 3-methylpentyl radicals. The latter have been produced by radiolysis of the corresponding iodides and the chlorides. Photolysis of 3-methylpentyl iodides in various organic glasses at 77°K produces, with low quantum yield, radicals formed by abstracting hydrogen atoms from matrix molecules, but no radicals formed by rupture of the carbon–iodine bond of the iodide, illustrating the importance of the cage effect in these systems. (auth)

31378 CHEMICAL STRUCTURE OF POLY(VINYL ALCOHOL)-METHYL METHACRYLATE GRAFT COPOLYMER PREPARED BY PRE-IRRADIATION TECHNIQUE. Sakurada, Ichiro; Ikada, Yoshito; Uesaki, Yoshiaki (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 47: 49-57(Jan. 1969).

Poly(vinyl alcohol) (PVA) films were pre-irradiated in air to a dose of 1.0×10^6R and graft copolymerization of methyl methacrylate (MMA) onto the film was carried out in methanol solution of the monomer which contained trichloroethylene to control the branch length. The graft copolymer was isolated from the grafting product by alternate extraction of the homoPMMA and the ungrafted PVA. The PVA part of the isolated graft copolymer was acetylated to make better the compatibility between the backbone and the branch and then fractionated into 13 fractions by addition of n-hexane to benzene solution of the acetylated graft copolymer. After acetyl groups in the fractionated graft copolymers were converted to hydroxyl groups again, 1,2-glycol bonds of backbone PVA was cleaved with periodic acid to separate the branch from the backbone polymer. The molecular weights of fractionated graft copolymers and the separated branches were measured by osmometry after acetylation of the PVA part. The chemical composition of each fraction was determined by hydrolysis of acetyl groups in the graft copolymer. From the result obtained it was found that the number of branch is only one per each graft copolymer molecule, while the backbone is formed from several mother PVA molecules, which are crosslinked. The chain length of homopolymer formed in the interior of the film was found to be approximately equal to that of the branch. (auth)

31379 CRYSTALLINE POLYMORPHISM AND BEHAVIOUR OF RECOIL ATOMS IN COPPER OXINATE. Yang, Mo-hsiung; Kudo, H.; Yoshihara, K. (Japan Atomic Energy Research Inst., Tokai). Radiochem. Radioanal. Lett., 1: 25-9(May 1969).

The relation between crystalline polymorphism and the behavior of recoil atoms in the anhydride and dihydrate of copper oxinate were studied. The results showed that the retention of ^{64}Cu recoil atoms by the α-form was smaller than that in the β-form both in the case of hydrate and anhydride. It was also found that annealing reactions have some relation with the initial retentions in copper oxinate as in the case of copper phthalocyanine. (P.C.H.)

31380 SPECIFIC FEATURES IN THERMAL ANNEALING OF RECOIL BROMINE ATOMS PRODUCED IN POTASSIUM BROMATE. Shiokawa, T.; Sasaki, T.; Takahashi, S. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett., 1: 31-5(May 1969).

The thermal annealing of recoil bromine atoms produced by isomeric transition in the ^{80m}Br-labeled potassium bromate crystal was studied. The isothermal annealing curves showed a specific feature which was characterized by maximum and minimum points. (auth)

31381 THE SZILARD–CHALMERS PROCESS IN METAL PHTHALOCYANINES AND ITS RELATION TO CRYSTAL MORPHOLOGY. Yoshihara, K.; Yang, Mo-hsiung (Japan Atomic Energy Research Inst., Tokai). Radiochem. Radioanal. Lett., 1: 37-40(May 1969).

Initial retentions and annealing reactions of α-copper phthalocyanine of various crystal sizes were studied. Initial retentions were not significantly affected by difference in crystal size. Effects on annealing were observed, especially in the annealing reaction of Stage II. (J.G.B.)

31382 A ^{188}Re GENERATOR USING ^{188}W. Blachot, J.; Herment, J.; Moussa, A. (Centre d'Etudes Nucleaires, Grenoble, France). Int. J. Appl. Radiat. Isotop., 20: 467-70(June 1969). (In French).

^{188}W is produced by double neutron capture on ^{186}W. The generator is prepared by absorbing the W on Dowex 1 in the fluoride form. Elution of the ^{188}Re is accomplished by means of a solution of $HClO_4$(1N). (auth) (UK)

31383 EFFECTS OF γ-RAY IRRADIATION ON CHEMICAL FORMS OF PHOSPHORUS OXYACIDS IN AQUEOUS SOLUTIONS. Kobayashi, M.; Kitaoka, Y.; Kiso, Y. (Kyoto Univ., Osaka). Radiochem. Radioanal. Lett., 1: 57-62(May 1969).

Aqueous solutions of hypophosphorus, phosphorus, and phosphoric acids in various concentrations were irradiated in a nuclear reactor. The effects of γ rays in the reactor on chemical forms of phosphorus oxyacids were examined as a function of the concentration of the solution. It was found that γ rays induce condensation reactions in the acids. (auth)

31384 RADIATION INDUCED INHIBITION OF THE β–α PHASE TRANSITION IN HYDROQUINONE. Lindquist, K. O.; Diethorn, W. S. (Pennsylvania State Univ., University Park). Int. J. Appl. Radiat. Isotop., 20: 551-2(July 1969).

The cage-like structure of β-hydroquinone can accommodate large amounts of rare gases, forming what is known as "clathrates." Evidence was obtained that the spontaneous transition of β-hydroquinone to the more stable α-form controls the slow gas release from the clathrate near room temperature. It was also shown that the gas release at all temperatures is reduced by a radiation dose of 10^8 R, and it was suggested that this was due to retardation of the $\beta \rightarrow \alpha$ phase transition by radioinduced crosslinking of the hydroquinone molecules. Extensive crosslinking would be necessary, implying a rather high G-value. It was further suggested that metastable states in the rare gas atoms may provide a very efficient mechanism for energy transfer to the hydroquinone and lead to high G-values. The question arose as to whether irradiation would retard the $\beta \rightarrow \alpha$ transition if all the cages in the β-structure were empty; the studies described showed that this is so, and that rare gas atoms play no essential role in the irradiation induced retardation of the transition. It is thought that this is the first reported instance of a radioinduced inhibition of a polymorphic phase transition in an organic solid. (UK)

31385 HCl RADIOLYSIS IN A NUCLEAR REACTOR. Oyola, Luis Rivera; Lee, R. A. (Puerto Rico Nuclear Center, Mayaguez). J. Nucl. Energy, 23: 251-6(May 1969).

Gaseous HCl was irradiated in quartz cells in a light water-cooled reactor operating at 1 MW. Irradiations were carried out in the pressure range 60 to 140 cm Hg of HCl for times of 15 and 25 min. The method of dosimetry used was to compare the radiolysis of HCl with that of nitrous oxide, irradiating one immediately after the other for the same time at approximately the same gas pressures. The Bragg–Gray theory of cavity ionization was used and corrections for the difference in stopping power of the two gases were made. A $G(H_2)$ value of 8.1 ± 0.4 was determined. In the Puerto Rico Nuclear Center reactor, at a point where the neutron flux is 5×10^{11} neutrons/cm^2/sec, the gammas are the dominant source of energy deposition. (auth) (UK)

31386 UNSTABLE INTERMEDIATES. PART LX. HO_2 RADICAL IN γ-IRRADIATED STRONTIUM CHLORIDE HEXAHYDRATE. Catton, R. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 9, 1393-5(1969).

Gamma irradiation of $SrCl_2,6H_2O$ at 77°K resulted in the formation of a radical having ESR parameters expected for HO_2. The

values of the proton hyperfine coupling along the g-tensor axes are $A_x = (-)12.7$, $A_y = (-)6 \pm 1$, and $A_z = (-)17.2$ gauss. These results are discussed in terms of a model in which the radical is compared with the hydroxyl radical. A reasonable fit is obtained for a bond angle of about 108° and a spin density of about 0.35 on the central oxygen atom. (auth) (UK)

31387 STRETCHING AND HEAT LIBERATION OF A BINDER CROSS-LINKED UNDER THE EFFECT OF GAMMA RADIATION. Shishkin, P. G. Prikl. Mekh., 5: No. 1, 28-32(1969). (In Russian).

Results are described of a study of the thermochemical and radiation processes involved in the crosslinking of one of the most commonly used polyester binders, PN-1, without filler. The study was made in order to determine linear shrinkage after formation of the gelatinous structure and to measure the amount of heat released in the course of crosslinking. Information on the shrinkage and heat liberation is necessary for the prediction of the internal stretching stresses in the glass-reinforced plastic parts during the process of binder consolidation. The crosslinking study was made without initiator on the UK-70,000 radiation test stand. ^{60}Co was used, which had a total activity of 70,000 gram-equivalent of Ra. The specimens were exposed to a 12-Mrad dosage (according to ferrosulfate dosimeter) at an intensity of 21.8 to 184 rad/sec, at an initial temperature of 283 to 288°K. (JPRS)

31388 RADIATION EFFECTS IN SINGLE-CRYSTAL AMMONIUM BIFLUORIDE AND SODIUM BIFLUORIDE. Kieft, Lawrence John Vande. Storrs, Conn., Univ. of Connecticut, 1968. 158p.

Thesis.

Electron spin resonance experiments were performed on single crystals of NH_4HF_2 and $NaHF_2$ at 77°K and at a frequency near 9.5 Gc/sec after irradiation with ^{60}Co γ rays and 1-MeV electrons. The γ irradiations at both 77 and 300°K produced no observed paramagnetic or color centers. The electron irradiations at 77°K produced both F_2^- molecular ions and trapped hydrogen atoms (H^0) and changed the samples from transparency to a deep blue-green color. A G value of 2.006 and an A value of 512.6 G were measured. The F_2^- defect in NH_4HF_2 was found in three inequivalent sites, one along the [100] direction and the other two in the bc plane with their magnetic z axes making angles of ±13.4° with the [010] direction. Values for the angles between the axes, the axial g tensor, and the A tensor are reported. $NaHF_2$ crystals have only one site for the $(FHF)^-$ ion and the F_2^- paramagnetic center. These have coincident axes; the radiation does not appear to change their directions from the axes of the bifluoride ions. Values for an axial g tensor and an axial A tensor are reported. Annealing experiments showed that the F_2^- and H^0 defects began to anneal at about 100°K for NH_4HF_2, while for $NaHF_2$ the F_2^- annealing threshold was much higher, about 175°K. Activation energies were calculated for the $F_2^- - H^0$ defect system for these two crystals. Values of 0.14 eV and 0.4 eV resulted for NH_4HF_2 and $NaHF_2$, respectively. Second-order kinetics fit the annealing data very well, and on the basis of this fit an annealing model was developed. Optically the two crystals behaved very similarly, producing absorption bands around 3100 Å and 6000 Å. Good correlation between the large optical absorption, near 3100 Å, and the ESR resonances for the F_2^- paramagnetic center was established by means of optical dichroism experiments. Alignment of the electric vector of polarized light parallel to the internuclear band for the F_2^- molecule produced far greater absorption than perpendicular alignment indicating that the ESR and optical absorption centers have parallel principal axes and are very likely identical. (Disser. Abstr.)

31389 LOW-TEMPERATURE IRRADIATIONS. Zagorski, Z. P.; Minc, S. (Inst. of Nuclear Research, Warsaw). Chem. Appl. Tech. Rep. Ser. No. 84, 67-87(1968).

Radiation chemistry of deep-frozen materials is reviewed from the point of view of phenomena characteristic of this particular form of radiolysis. Differences of chemical end-points in the liquid and frozen state are stressed. Special attention is paid to the identity and migration of intermediate species at the temperature of irradiation and at higher temperatures (thawing). Examples are given to show the importance of luminescent phenomena. Low-temperature radiation chemistry of particular systems (from water to those occurring in outer space chemistry) is reviewed. In experimental considerations the role of the structure of frozen solids is discussed and the need for additional investigations put forward. (auth) (NSA of Poland)

31390 THE DECOMPOSITION OF SOLUBLE COLLAGEN BY γ-IRRADIATION. Cooper, D. R.; Russell, A. E. (Rhodes Univ., Grahamstown, South Africa). Biochem. J., 113: 263-9(June 1969).

The effect of γ-irradiation in the range 1 kRAD to 10 MRADs on freeze-dried acid-soluble collagen was studied. The specific rotation and reduced-viscosity recoveries after heating and cooling of the irradiated collagen in solution showed a high degree of dependence on irradiation dose, with reduced viscosity showing significantly less recovery than specific rotation on increasing the irradiation dose. The dependence of reduced viscosity on concentration was greatly decreased with increased doses of γ-irradiation. The melting temperature measured by optical rotation also decreased as the irradiation dose was increased, and at low doses was distinctly biphasic. Physical properties showed that the action of γ-irradiation up to 10 MRADs occurred in two distinct phases, with the early changes being extremely sensitive to irradiation dose. The action of the γ-irradiation is discussed in terms of the structure of tropocollagen. (auth) (UK)

31391 INFLUENCE OF ION EXCHANGE PROPERTIES ON RADIOLYSIS OF KB-4P-2 RESIN. Semushin, A. M.; Kuzin, I. A.; Galitskaya, I. A. Zh. Prikl. Khim., 42: 829-32(Apr. 1969). (In Russian).

The effects of constant and variable valence ions (H^+, Na^+, K^+, Ca^{2+}, Ba^{2+}, Be^{2+}, Mn^{2+}, Cu^{2+}, Al^{3+}, and Fe^{3+}) on the radiochemical stability of water-saturated resins were studied. The results showed that the water-saturated resin KB-4P-2 depends on ion properties to a greater degree than the sulfur-containing resin KU-2. It is stressed that this should be taken into consideration during the absorption of radioactive isotopes from solutions of high specific activity. (R.V.J.)

31392 PREPARATION OF WEIGHABLE AMOUNTS OF ^{231}Pa FROM NEUTRON-IRRADIATED THORIUM. Spitzyn, Victor I.; D'yachkova, R. A.; Kamenskaya, A. N. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 184: 379-82(Jan. 11, 1969). (In Russian).

The preparation of weighable amounts of ^{231}Pa using neutron-irradiated Th was studied because the former isotopes may be transformed into ^{232}U by neutron irradiation. A pH = 1.6 nitric acid solution, obtained by the leaching of ^{233}U from Th irradiated in a thermal reactor served as a working solution; it contained 170 g/l of Th with about 1 g of ^{231}Pa per ton of Th. The Pa was concentrated from the Th-containing solution with silica gel under dynamic conditions. The ^{233}Pa was completely absorbed up to a volume ratio of sorbent : solution = 1 : 100; under the same conditions, the sorption of ^{231}Pa from the solution of irradiated Th resulted in an increase of about 40% of Pa. The desorption of Pa from the silica gel was carried out with 0.25 M oxalic acid solution, resulting in the formation of stable complexes. The γ spectrum of the oxalic acid solution yielded peaks belonging only to ^{125}Sb and ^{231}Pa; the α spectrum contained only ^{231}Pa peaks. The concentration of ^{231}Pa in the solution amounted to about 12 mg/l; it may be further concentrated without carrier by the hydrolytic decomposition of the complex and precipitation of the protactinium hydroxide, or with calcium oxalate carrier. (TTT)

31393 PULSE-RADIOLYSIS STUDY OF THE FORMATION OF BENZYL RADICALS FROM BENZYL CHLORIDE IN CYCLOHEXANE IN THE GAS PHASE. Johnson, G. R. A.; Sauer, Myran C. Jr.; Warman, John M. (Argonne National Lab., Ill.). J. Chem. Phys., 50: 4933-42(June 1, 1969).

The yield of benzyl radical (Bz) formed by electron-beam pulse radiolysis of benzyl chloride (BzCl) in cyclohexane vapor (1.3 atm/120°C) was studied by optical absorption measurements. Electron scavengers lower the benzyl radical (Bz) absorption by competing with dissociative electron capture by BzCl. A study of this competition gave the relative rate constants for electron capture at 120°C ($SF_6 = 1$): $BzCl = 1.6 \times 10^{-3}$, $CCl_4 = 0.3$, $CH_2Br = 5 \times 10^{-5}$, $C_6H_5NO_2 \sim 2 \times 10^{-2}$. The maximum depression of the absorption, $\Delta(Bz)_{max}$, which was independent of the electron scavenger used and of the BzCl concentration (0.2 to at least 4 mole %), is believed to correspond to the yield of Bz from dissociative capture. With benzyl bromide, acetate, and formate in cyclohexane, $\Delta(Bz)_{max}$ was the same as with benzyl chloride. Bz is also formed by processes other than dissociative capture which are not influenced by electron scavengers. The yield from these processes increases with increasing BzCl concentration. Using electron beam radiolysis, the decomposition of BzCl due to dissociative capture, measured by chemical analysis, $G(-BzCl)^e = 2.6 \pm 0.4$ molecules per 100 eV. ^{60}Co γ-radiolysis gave $G(-BzCl)^e = 4.3 \pm 0.1$, which is close to the value expected if all of the electrons react by dissociative capture. Possible reasons for the low value with electron radiolysis are discussed. (auth)

Radiochemistry

Refer also to abstract 31452.

31394 VARIATIONS WITH BOND TYPES OF THE YIELDS FOR DEUTERIUM-ATOM ABSTRACTION BY 2.8-eV TRITIUM ATOMS. Chou, C. C.; Smail, Thomas; Rowland, F. S. (Univ. of California, Irvine). J. Amer. Chem. Soc., 91: 3104-5(May 21, 1969).

A series of abstraction reactions from deuterated compounds were carried out with 2.8-eV tritium atoms from the 1849-Å photolysis of TBr. A characteristic, strong dependence of abstraction yield upon the nature of the attacked C–D bond was observed. (P.C.H.)

Separation Processes

Refer also to abstract 31361.

31395 (ARH-SA-28) RECOVERY OF PALLADIUM FROM NUCLEAR WASTE SOLUTIONS USING A PACKED COLUMN OF TRICAPRYL MONOMETHYL AMMONIUM CHLORIDE ON AN INERT SUPPORT. Colvin, C. A. (Atlantic Richland Hanford Co., Richland, Wash.). [1969]. 12p. (CONF-690606-2). Dep. CFSTI.

From 24th Northwest Regional Meeting, American Chemical Society, Salt Lake City, Utah.

Palladium is present in supernatant solutions in high-salt wastes stored following the recovery of actinides from irradiated uranium. A particular means to isolate palladium from waste solutions was demonstrated. Palladium is preferentially retained on a packed column of Aliquat-336 (tricapryl monomethyl ammonium chloride) fixed on an inert support. A homogeneous powder, uniformly coated with the amine extractant, is prepared by dissolving Aliquat-336 in xylene, mixing with Plaskon (a trifluorochloroethylene polymer), and volatilizing the xylene. The powder, mixed with asbestos (flow rate aid), was packed in an 8 mm column. High-salt basic waste solution was passed through the column until 50 percent palladium breakthrough was achieved, resulting in 13.3 mg of palladium present on the 446 mg of Aliquat-336. Elution was accomplished by cycles of 8.0M HNO_3 and 1.5M NH_4OH. The first cycle of 8.0M HNO_3 resulted in the recovery of 55% of the palladium in 35 ml of eluent (0.22 g/l Pd). The first cycle of 1.5M NH_4OH recovered an additional 25% in 30 ml of eluent. The total recovery of palladium from the column in three complete elution cycles was 97%. (auth)

31396 (ARH-SA-35) THE NEPTUNIUM MEASUREMENT SYSTEM OF THE PUREX FUELS SEPARATIONS PLANT. Taylor, L. H. (Atlantic Richfield Hanford Co., Richland, Wash.). [nd]. 8p. (CONF-690606-4). Dep. CFSTI.

From 24th Northwest Regional Meeting, American Chemical Society, Salt Lake City, Utah.

The measurement system used to provide process control and material accountability in the recovery of neptunium from irradiated reactor fuels requires a variety of analytical methods. The feed stream containing a large quantity of fission products and uranium with low neptunium concentration is measured with a ^{239}Np spike, alpha-gamma counting method. The product stream is analyzed by an alpha-count-alpha energy method. The waste streams from solvent extraction were analyzed by alpha counting methods with solvent extraction purification of the sample. The loss to the fuel cladding wastes was determined from the ^{137}Cs content of the stream. Evaluation of the overall system is made from a statistically based automated standards program. (auth)

31397 (CEA-CONF-1265) RADIOLYSIS AND HYDROLYSIS OF TBP AND THEIR EFFECTS. Faugeras, Pierre; Talmont, Xavier (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 25p. (CONF-680953-2). Dep.

From 5th International Conference on the Chemistry of Extraction by Solvents, Haifa and Jerusalem, Israel.

Studies were made on the reprocessing of plutonium and uranium fuels and the zirconium decontamination factor using TBP. The hydrolysis and radiolysis of TBP during the reprocessing is discussed. Possible methods for suppressing the effects of radiolysis and hydrolysis of the solvent are proposed. (P.C.H.)

31398 (CEA-R-3753) COMPARATIVE STUDY OF THE IONIC EXCHANGE OF Ca^{++}, Sr^{++}, AND Ba^{++} CATIONS ON RESINS AND INORGANIC EXCHANGERS. Sanchez Batanero, Pedro (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1969. 150p. (In French). Dep.

With a view to applying the results to certain problems related to chemical separations in activation analysis, a study was made of the possibilities of separating the alkaline earth elements Ca, Sr, and Ba on organic resins and inorganic exchangers using the radioactive indicator method. The partition coefficients of the cations Ca^{2+}, Sr^{2+}, and Ba^{2+} were measured on Dowex 50 W $(NH_4^+) \times 8$ resin in the presence of EDTA–NTA–EGTA and DCTA as complexing agents, and on zirconium phosphate, tungstate, and molybdate in the presence of HCl and NH_4Cl. Methods were developed for separating mixtures of alkaline earth elements using DCTA-NH_4 followed by elution on Dowex 50 W $(NH_4^+) \times 8$ resin columns and on zirconium phosphate. Among the complexing agents used on the ion-exchange resins the most promising appears to be DCTA, which leads to partition coefficients for Ca, Sr, and Ba that are very different. Results of measurements of partition coefficients on zirconium phosphate (NH_4^+ form) using DCTA-NH_4^+ show possibilities for separations on columns. Separation of alkaline earth elements on zirconium phosphate seems to be less quantitative than on Dowex 50 resin; it is however much faster in the former case and can be useful for treating short-half-life radioisotopes in activation analysis. (auth)

31399 (CONF-681032–, pp 131-49) CHEMICAL PROPERTIES OF ^{252}Cf. Baybarz, R. D. (Oak Ridge National Lab., Tenn.).

Some chemical properties of the transplutonium elements are described, from which chemical flow sheets may be designed for isolation and purification of these elements. Methods for separation of actinides from rare earths are considered. An anion exchange method for separation of californium is described along with the Tramex process. (M.C.G.)

31400 (EUR-4232) ISOLATION OF AMERICIUM AND CURIUM FROM IRRADIATED ^{241}Am TARGETS. Mueller, W.; Maino, F.; Toussaint, J.-Cl. (European Atomic Energy Community, Karlsruhe (West Germany). Transuranium Inst.). Dec. 17, 1968. 20p. Dep.

At the European Transuranium Institute irradiated ^{241}Am targets were processed to isolate the heavy nuclides ^{238}Pu, ^{242}Pu, ^{241}Am, and ^{242}Cm. The initial α activity, mainly due to ^{242}Cm, exceeded 3 kCi. The americium-curium fraction was separated from plutonium and fission products by anion exchange from 8 M HCl and 10 M LiCl solution. Americium and curium were precipitated as oxalates and the mixture of the oxalates was transformed into oxides. In order to demonstrate the potential use of ^{242}Cm as a heat source, 4.3 g of the oxide mixture containing approximately 400 mg ^{242}Cm were loaded into a platinum capsule that was sealed by welding. The platinum capsule served to fuel a prototype of a radioisotope power generator. (auth)

31401 (EUR-4242) PYROCHEMICAL SEPARATION OF PLUTONIUM IN IRRADIATED FUEL ELEMENTS. Avogadro, A.; Wurm, J. G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 15p. (In French). (CONF-681040-13). Dep.

From Symposium on Nonaqueous Reprocessing, Mol, Belgium.

A hybrid fuel cycle is investigated. This concept involves Pu separation in an integrated pyrochemical plant followed by its final purification in a central plant by existing aqueous technology or by fluoride volatility processes. The pyrochemical flow sheet being considered involves the oxidation of ceramic fuel in a nitrate melt followed by selective dissolution of the U in a fused chloride bath. This fuel cycle concept, which combines the advantages of dry and aqueous reprocessing is economically attractive. (auth)

31402 (JUL-568-RB) APPARATUS AND RADIOCHEMICAL PROCEDURES FOR URANIUM LEACH TESTS OF IRRADIATED COATED PARTICLES. Stoeppler, Markus (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Dec. 1968. 18p. (In German). Dep.

A leach arrangement for ~0.1 g coated particles with high burnup in a 10-cm lead cell is described. The transport tube for the sample is also part of the dissolving vessel, which eliminated a noticeable contamination of the cell interior. Addition of the acid and rewashing of the apparatus took place from outside the cell. The decontamination behavior and uranium yields are discussed. Development of apparatus for higher activities and larger amounts of sample is considered. (tr-auth)

31403 (KFK-920) ^1H AND ^{31}P NMR INVESTIGATION OF THE EXTRACTION PROPERTIES OF ORGANOPHOSPHORUS COMPOUNDS. II. THE SYSTEM TRIBUTYLPHOSPHATE–DODECANE–URANYL NITRATE–HNO_3–H_2O. von Ammon, R.; Baumgaertel, G.; Dressler, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Feb. 1969. 26p. (In German). Dep.

The influence of the uranium concentration on the chemical shift of the α–CH_2 protons, the phosphorus atom, and the HNO_3/H_2O protons in the system TBP–dodecane–uranyl nitrate–HNO_3–H_2O was investigated. In almost all cases a negative total shift was observed. Complex formation in the system was studied by NMR techniques. (M.C.G.)

31404 (NP-17894) INPUT TANK CALIBRATIONS AT THE EUROCHEMIC PLANT. Franssen, F.; Frenzel, W. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Feb. 1969. 33p. (ETR-236). Dep.

Volume determination of an input batch at Eurochemic, is, in addition to sampling and analysis, one of the three basic steps of the nuclear material input measurement operation. The means and methods of input measurement applied at Eurochemic are sum-

marized. The analytical procedures, however, are not considered. The installation of input measurement tanks and calibration procedures are described. The tank calibration results are reported and an error estimate for the tank calibration as well as for the volume measurement, based on these calibrations, is discussed. Additional checks, made to test the homogenization of input solutions, are considered. (auth)

31405 (ORNL-TM-2573) LICENSING OF REPROCESSING PLANT OPERATORS. Brooksbank, R. E.; Skovholt, D. J.; Lewis, W. H. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 30p. Dep. CFSTI.

Federal regulations require that operators in a nuclear fuel reprocessing plant be licensed in a manner similar to that required for licensing reactor operators. In accordance with these regulations, operators at the Nuclear Fuel Services (NFS) Plant were trained, examined, and licensed. The program followed in licensing these operators is described. The statutory requirements for licensing are reviewed. The four categories of operators (and of licenses) are described. The training program that was used at NFS is outlined; both the written and the oral examinations that were used are discussed, and the results of the testing are summarized. (auth)

31406 ELECTROLYTIC PROCESS FOR HEAVY WATER PRODUCTION. (to Atomic Energy of Canada Ltd.). British Patent 1,152,094. May 14, 1969. Priority date Feb. 16, 1966, Canada.

A process for increasing the proportion of D_2O in water comprises electrolyzing water in an electrolytic cell using electrodes of a transition metal or a transition metal alloy and adding a readily polarizable substance to the water in a concentration of from 3 to 10 ppM. The polarizable substance is selected from ionizable cyanides, benzotriazole, pyrazole, diphenylamine, pyridine, aniline, imidazole, and substances of the general formula $H_2N-\underset{\underset{X}{\|}}{C}-Y$ where X is an O or S atom or an = NH group and Y is a group having N or O bonded directly to the C atom. An electrolyte selected from the group consisting of NaOH, KOH, or K_2CO_3 is also added to the water. (B.L.M.)

31407 METHOD FOR THE SEPARATION OF GENETICALLY CONNECTED ISOBARIC AND ISOMERIC PAIRS OF RARE EARTH NUCLIDES. Beyer, G. J.; Grosse-Ruyken, H.; Khalkin, W. A. (Joint Inst. Nuclear Research, Dubna, USSR). J. Inorg. Nucl. Chem., 31: 1865-7(June 1969). (In German).

Discontinuous and continuous methods are proposed, using the Szilard-Chalmers effect in polyaminocarbonate complexes. The discontinuous method uses EDTA or DTPA and a strongly acid cation exchanger to adsorb the non-complexed daughter nuclides. The continuous method uses adsorption of the DTPA complex on a strongly basic anion exchanger, followed by transfer to a small anion exchange column and elution of the daughter nuclides. Examples of separations studied were $^{144}Ce/^{144}Pr$, $^{134}Ce/^{134}La$, $^{140}Nd/^{140}Pr$, and $^{160m}Ho/^{160g}Ho$ by the discontinuous method, and $^{140}Nd/^{140}Pr$ by the continuous method. (UK)

31408 OXYGEN ISOTOPE FRACTIONATION FACTOR BETWEEN CO_2 AND CO_3^{2-}. Sharma, S. K.; Sharma, T. (Indian Inst. of Tech., Kanpur). J. Mass Spectrom. Ion Phys., 2: 367-71(May 1969).

Carbonate samples were decomposed with 100% phosphoric acid at temperatures ranging from 25 to 62°C. The fractionation factor α is determined for the $CO_2-CO_3^{2-}$ system at these temperatures. It was found that the α values vary inversely with temperature of decomposition of carbonates, as predicted by the theory. (auth)

31409 EXTRACTION OF LANTHANIDES AND ACTINIDES BY ALKYLPHOSPHINE OXIDES. PART IV. EXTRACTION OF TRIVALENT CATIONS BY TRIBUTYLPHOSPHINE OXIDE AND TRIOCTYLPHOSPHINE OXIDE. Goffart, J.; Duyckaerts, G. (Univ., Liege). Anal. Chim. Acta, 46: 91-8(June 1969). (In French).

The extraction of trivalent lanthanides and actinides by trialkylphosphine oxides is based on the equilibrium $Me_{aq}^{3+} + 3\ NO_{3aq}^{-} + 3\ Alk_3PO_0 \rightleftharpoons Me(NO_3)_3 \cdot 3\ Alk_3PO_0$. At constant ionic strength (2 M sodium nitrate), the equilibrium constants for the complex formed between tri-n-octylphosphine oxide in n-octane and ^{241}Am or ^{244}Cm were calculated; the values are, respectively, $(2.9 \pm 0.5) \cdot 10^7\ M^{-3}$ and $(1.7 \pm 0.15) \cdot 10^7\ M^{-3}$. The distribution of lanthanides and actinides between 0.1 M tri-n-butylphosphine oxide in benzene and nitric acid solutions of different concentrations was examined and discussed. (auth)

31410 MECHANISM OF THE EXTRACTION OF TANTALUM AND NIOBIUM FROM HYDROFLUORIC ACID SOLUTIONS USING TRIBUTYL PHOSPHATE. Korovin, S. S.; Kol'tsov, Yu. I. Zh. Neorg. Khim., 14: 1062-4(Apr. 1969). (In Russian).

The distribution of niobium and tantalum between TBP and hydrofluoric acid solutions was studied. From the distribution and ir spectral data it was concluded that at hydrofluoric acid concentration of less than 1 mole/l, tantalum, in contrast to niobium, is extracted chiefly according to the solvate mechanism in the form of complexes $Ta(OH)F_4 \cdot nTBP$ and $TaF_5 \cdot nTBP$. (tr-auth)

31411 REACTION OF NIOBIUM AND TANTALUM CHLORIDES WITH TRIBUTYL PHOSPHATE IN THE PRESENCE OF WATER. Kol'tsov, Yu. I.; Korovin, S. S.; Petrov, K. I. Zh. Neorg. Khim., 14: 1065-7(Apr. 1969). (In Russian).

Results from a study of the spectra of tantalum pentachloride and niobium pentachloride in TBP, containing water, showed that the complexes of niobium and tantalum extracted from hydrochloric acid solutions contain the group Me = O. Both metals were extracted according to the solvate mechanism, which excludes the extraction in the form of complex chlorine-containing acids. The most probable forms solvated were $Me(OH)Cl_4$, $MeOCl_3$, $MeO(OH)Cl_2$ with one or two molecules of TBP. (tr-auth)

31412 EXTRACTION OF MACRO AMOUNTS OF CERIUM(IV) BY DICRESYL PHOSPHATE. Fomin, V. V.; Potapova, S. A. Zh. Neorg. Khim., 14: 1068-71(Apr. 1969). (In Russian).

The extraction of cerium(IV) from weakly nitrate solutions by dicresyl phosphate was studied. The cerium(IV) was extracted in the form of a polymer compound. (tr-auth)

31413 THE ADSORPTION OF URANIUM HEXAFLUORIDE, III. Mueller, L. (Mecsek Ore Mining Enterprise, Pecs, Hungary). Acta Chim. Acad. Sci. Hung., 59: 277-96(1969).

The selective determination of mass diffusion and molecular separation process in UF_6 adsorber systems was investigated. The interpretation of convection-free diffusion processes was undertaken by utilization of the Schmith-Wakao model, and transport equations were derived for adsorbable and non-adsorbable pairs of gases. After a description of experimental equipment, the validity of diffusion equations is proved. For columns packed with various adsorbents, the ratio of molecular separation and mass diffusion UF_6 material flow is determined as a function of experimental parameters. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstract 31512.

31414 (ANL-Trans-748) DIFFUSION OF RADIOACTIVE DECAY PRODUCTS IN MONAZITES. Voronovskii, S. N.; Magomedov, Sh. A. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Geokhimiya, No. 2, 185-90(1969). 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared in NSA 23: 15968. (R.C.K.)

31415 (DP-1160) INFLUENCE OF GRAVEL LAYERS ON SOIL MOISTURE CONTENT AND FLOW. Corey, John C.; Horton, J. Henry (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1969. Contract AT(07-2)-1. 23p. Dep. CFSTI.

Calculations and experimental measurements indicated gravel lenses are unsuitable for diverting water around large burial trenches. The calculations suggest that leaching of radionuclides from the interior of process equipment is unlikely until the soil is saturated near the equipment. (auth)

31416 (EUR-3741(Vol.2)) GENERAL STUDY OF RADIOACTIVITY OF THE RHINE BASIN. PART IV. GENERAL THEORETICAL STUDY. (European Atomic Energy Community). 1968. 421p. (In French). Dep.

Contamination conditions of the subterranean and surface waters of the Rhine basin by natural and artificial radioactivity were examined. The examinations led to the conclusion that the hydrological conditions of the contamination of the subterranean and surface waters by radioactive fallout showed that in the summer there is a concentration of the active substances in the soil waters and that, if a large part of the radionuclides is not fixed by the substance of the soil, the abundant precipitations cause soil waters of high activity in the deepest layers of the subsoil. With respect to the very active accumulation of the radioactivity coming from fallout because of chemical and biological processes, it was found that the nature of the utilization of the soil (type of forest, pasturage, etc.), the nature of the soil itself, and the chemical behavior of the soil and the rocks of the subsoil influence the degree of contamination. It was also observed that prolonged residue time of radionuclides in the atmosphere can constitute a determining factor in the decrease of the radioactivity from fallout. With respect to the accumulation of the radionuclides in the soil, the atomic decay at the interior of the fluvial basin should be considered. It was established that contamination from the use of isotopes in industry was partially due to short-lived isotopes. The possibility of an autodecontamination of the fluvial water by lasting fixation of the radionuclides to mud particles was shown. (tr-auth)

31417 (HMI-B-82) CORRELATION BETWEEN FALLOUT FROM NUCLEAR WEAPONS TESTS AND FISSION PRODUCT ACTIVITY IN RIVER WATER. Jacobi, W.; Eichler, J.; Stolterfoht, N. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Mar. 1969. 56p. (In German). Dep.

A correlation analysis between fallout from nuclear weapon tests and total β-activity of fission products in river water in the years 1956 to 1965 was carried out for 17 rivers in the Federal Republic of Germany. The results show that in good approximation a linear relation between the specific activity in the river water, the mean fallout rate, and the accumulated fission product activity in the ground of the river drainage area exists. The mean correlation factors of the rivers are given. (auth)

31418 (NVO-1229-98) INVESTIGATIONS OF SURFACE PROPERTIES OF GEOLOGIC MATERIALS. I. MEASUREMENT OF APPARENT SURFACE AREAS BY THE VOLUMETRIC, GAS-ADSORPTION METHOD. Carnahan, C. L.; Castagnola, D. C.; Smith, M. E. (Isotopes, Inc., Palo Alto, Calif.). Oct. 1968. Contract AT(29-2)-1229. 53p. Dep. CFSTI.

Apparatus was constructed for the measurement of low-temperature gas-adsorption isotherms of geologic materials by the static, volumetric method. Adsorbates were nitrogen and argon, and adsorption experiments were conducted at 77°K (-196°C). The samples were granite from the SHOAL site, RAINIER melt and chimney rubble, a carbonate rock, and a pumice. The rocks were crushed and separated into six to nine particle-size fractions ranging in particle diameter from less than 62 to 16,000 microns (less than 0.062 to 16 millimeters). Gas-adsorption isotherms were measured both before and after several of the samples were equilibrated with native or simulated native ground water. The isotherm data were used to calculate apparent specific surface areas by the theory of Brunauer, Emmett, and Teller. The granite, melt, carbonate, and pumice samples exhibited surface areas which decreased roughly with the reciprocal of particle diameter in the small particle-size ranges, but approached constant values at large particle sizes. The rubble samples (zeolitic tuff) showed only very slight variation in surface area over the entire range of particle size. The granite and, possibly, melt samples displayed particle-size-dependent variations in surface area before and after equilibration with ground water, while surface areas of rubble samples were apparently unaffected by equilibration. Due to extremely low surface areas displayed by some geologic materials, it was concluded that krypton would be a more useful adsorbate than either nitrogen or argon in gas-adsorption experiments. The gas-adsorption method is a useful tool by which surface activities of rocks can be compared. (81 references). (auth)

31419 (UCRL-50627) EQUATION-OF-STATE MODEL FOR NONCOMPACTED MATERIALS. Richter, H. P. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 4, 1969. 20p. Dep. CFSTI.

An equation-of-state model is discussed that permits the calculation of release isentropes for porous and nonisotropic materials such as tuff and alluvium. The model is tested on experimental values obtained from shock experiments on reconstituted Scroll tuff (density 1.4 g/cm^3 and sonic velocity of about 1940 m/sec). The calculated and measured values for the compressive curve and release isentropes agree within the range of experimental error. Since the release isentropes issuing from the compressed material normally do not reproduce the porous structure before compression, the 0°K isotherm is translated to make it possible to use the Mie-Grüneisen equation of state. Also discussed are the mathematical procedures required when an initial-point value for the Grüneisen ratio is not measured. Other methods for curve fitting and determination of equation-of-state parameters are mentioned. (auth)

31420 ON THE QUESTION OF THE CAPACITY OF THE RHINE FOR RADIOACTIVE NUCLIDES. SORPTION OF RADIONUCLIDES BY SEDIMENTS OF THE RHINE. Schneider, Horst; Block, Wolfram (Isotopenlaboratorium, Koblenz, Ger.). Gas-Wasserfach, 109: 1410-15(Dec. 13, 1968). (In German).

For estimation of the action of decontaminating sediments and suspended material in rivers charged with radionuclides, the sorbability of deposits of the Rhine for several nuclides was determined; the sorbability increases in the following order: I$^-$, Sr(II), Pu(IV), Zn(II), Cs(I). Saturation was reached by sediments after 24 hr, at the latest, for all nuclides. The sediment samples were taken from Oehningen (Upper Rhine), Koblenz (Middle Rhine), and Wesel (Lower Rhine). Data were compared with the organic content for each sample. The sorption of ^{137}Cs is dependent on grain size but not on organic material. A sudden release by living or dead organic material of radionuclides is not possible, though desorption from mineral suspended material is more rapid, often occurring within a few hours. Less than 1% of transported nuclides in the Rhine under any conceivable conditions would be bound to suspended material or sediments. (BBB)

31421 DISTRIBUTION OF RADON CONTENT OF GAS ASSOCIATED WITH SPRING WATERS AT AWARA HOT SPRINGS. Katsura, Kyozo; Hatsuda, Jinichiro (Kyoto Univ.). Onsen Kagaku, 19: 105-10(Dec. 1968). (In Japanese).

^{222}Rn content of gas associated with spring water at Awara Hot Springs in Fukui Prefecture was measured as an aid to determine the position of planned deep test drilling. The iso-Rad contours obtained revealed a pattern roughly resembling that of isothermals of spring water. The striking feature of the radon distribution is that the iso-Rads show an oval with a major elongation in NE-SW direction and a minor one in NW-SE direction. These two directions may suggest the tectonic lines existing in the basement. (NSA of Japan)

31422 MARINE GEOCHEMISTRY OF FLUORINE. Carpenter, Roy. San Diego, Calif., Univ. of California, 1968. 149p. Thesis.

The behavior of fluorine in the major sedimentary cycle was investigated with analyses of minerals from marine and terrestrial sediments. Fluorine was determined by a simple, nondestructive photon activation technique that had a lower limit of about 5 ppM F and a precision of 3 to 5%. The energy of the photons must be above the threshold of the (γ,n) reaction on ^{19}F but below those of reactions that would produce interfering radioactive nuclides. Calcium carbonate precipitation appears to dominate the removal of dissolved fluoride from sea water, with incorporation into cal-

cium phosphates apparently the next most important removal mechanism. The residence time of the fluoride ion in sea water is calculated from its sedimentation rate to be a few million years, similar to that of calcium. Fluorine is being removed from sea water about 100 times faster than chlorine. Calcium carbonate and phosphate precipitation together can account for at most 10 to 20% of the dissolved fluoride brought annually by rivers to the oceans. Atmospheric precipitations contain enough fluoride to provide most of the fluoride in the river waters. Only a small fraction of the fluoride found in atmospheric precipitations can be explained by volcanic and industrial inputs; the major part has apparently come from the sea. The F/Cl ratio in rain and snow is about 100 times that in sea water. Since most of both the fluorine and the chlorine are believed to come from the sea, fluorine is apparently being preferentially injected into the atmosphere at the sea surface. As atmospheric precipitation weathers crustal rocks and soils it dissolves out relatively little fluorine. Most of the fluorine mobilized during weathering remains bound in the detrital minerals such as the clays, which are carried in suspension by the rivers. The fine grained detrital minerals, upon reaching the sea, remove very little fluoride from solution as they pass to the sediments. They do contain relatively large amounts of fluorine, but they play only a very minor role in removing fluoride from sea water. (Disser. Abstr.)

31423 ACCUMULATION OF ^{235}U FISSION PRODUCTS ON POLYMICRON RIVER SEDIMENTS. Wanderer, E. (Institut fuer Strahlenschutz, Seibersdorf, Austria). Naturwissenschaften, 56: 281(May 1969). (In German).

Adsorption experiments with ^{235}U fission products and river sediments were carried out. The relation of particle size to adsorption was determined for ^{140}La, ^{103}Ru, and ^{132}Te as well as total beta activity. The adsorption maximum was in the particle size region of 75 to 100 μ. (M.C.G.)

31424 USE OF ENVIRONMENTAL ISOTOPES IN HYDROLOGY: RESULTS FROM WMO/IAEA NETWORK. Meyer, G. L. (International Atomic Energy Agency, Vienna). World Meteorol. Organ. Bull., 18: 81-5(Apr. 1969).

For the past seven years, more than 100 weather stations from 67 countries and territories have been collecting monthly precipitation samples for the WMO/IAEA Isotopes-in-Precipitation Network. Analyses of the oxygen and hydrogen isotope content from these samples have been used to answer successfully, and sometimes uniquely, questions and problems in the fields of meteorology, oceanography, and hydrology. These developments and future plans are discussed. (auth)

31425 GEOLOGICAL SURVEY RESEARCH, 1969. CHAPTER B. Geological Survey Professional Paper 650-B. Washington, D. C., U. S. Government Printing Office, 1969. 207p. $2.75. (NP-17863).

Forty papers are included. A separate abstract was prepared for each of five papers. The remaining 35 papers include general information on geology, hydrology, and related fields not within scope of NSA. (R.C.K.)

For abstracts of individual sections see: 31426–31428, 31438, and 31442.

31426 CORRELATION OF CARBONATE ROCK UNITS IN NORTHWEST OHIO BY NATURAL GAMMA LOGGING. Norris, Stanley E.; Fidler, Richard E. (Geological Survey, Columbus, Ohio). U. S., Geol. Surv., Prof. Pap. 650-B, 158-61(1969).

Natural gamma logs are a basis for determining the contact between the principal carbonate rock units in northwest Ohio, those of the Niagara and Cayuga Groups. Logs of the upper part of the Niagara group, a dolomite of high purity, show a relatively low intensity of radiation and are almost featureless, in marked contrast to logs of the slightly less pure dolomite of the overlying Cayuga rocks. A characteristic change in radioactivity at or near the contact is identifiable on most logs in the study area. Data from 26 wells, supplemented by that obtained from quarry exposures, have been used to construct a structure contour map which conforms closely to the known regional structure. This map will be a significant aid in the interpretation of the hydrogeologic system in northwest Ohio. (auth)

31427 THE AGES OF THREE URANIUM MINERALS, MOJAVE DESERT, CALIFORNIA. Hewett, D. F.; Stone, Jerome; Stieff, Lorin R. (Geological Survey, Menlo Park, Calif.). U. S., Geol. Surv., Prof. Pap. 650-B, 84-8(1969).

The Mojave Desert region of southeastern California contains many coarse-grained quartz monzonite intrusions whose ages are important to the understanding of the region's geologic history. Betafite from one pegmatite and polycrase from another indicate ages that may range from 72 to 80 Myr, or the Late Cretaceous. Uraninite has been found in a crushed zone in quartzite about 21 miles southeast of Twenty-nine Palms. (auth)

31428 RADIOCARBON DATING OF ASH DEPOSITS ON AMCHITKA ISLAND, ALASKA. Shacklette, Hansford T.; Rubin, Meyer (Geological Survey, Denver). U. S., Geol. Surv., Prof. Pap. 650-B, 81-3(1969).

Peat deposits on the tableland of Amchitka Island contain 3 layers of volcanic ash, each about 1 to 2 cm in thickness. Radiocarbon dates of discrete plant stems from these ash layers indicate that the age of the uppermost ash deposit is 725 ± 250 years B.P. The two lower ash layers lie about 7 cm apart; the average of their dates is 1,845 years B.P. The amount of peat above the ash layers indicates that average rates of accumulation are approximately 0.2 cm/yr for fibrous to mucky peat, and 0.052 cm/yr for the more completely humified and compacted peat (muck). The total depth of peat at this location (2.8 m) indicates that about 3,400 years was required for the formation of this deposit. It is estimated, therefore, that this tableland has borne a vegetation mantle no longer than 4,000 years. (auth)

Meteorology

Refer also to abstracts 31424 and 31446.

31429 (AD-681860) THE TERF PROGRAM AND ITS APPLICATIONS TO THE CALCULATION OF FALLOUT RADIATION DOSE. Final Report, June 1967–January 1969. Goldstein, Robert A. (Mathematical Applications Group, Inc., White Plains, N. Y.). Jan. 1969. 77p. (USNRDL-TRC-68-56). CFSTI.

TERF is a Monte Carlo radiation transport code for computing gamma-ray dose due to fallout on non-uniform terrain. The code incorporates extensive geometry capabilities including the unique ability to convert elevation contour line data into three-dimensional terrain representations. A variety of calculations concerned with the effects on the dose of various terrain features, structures, and vegetation, are described. (auth) (USGRDR)

31430 (AD-684330) ENVIRONMENTAL MONITORING PROGRAM, 1968. Annual Summary Report, January 1–December 31, 1968. Clements, Lynn C.; Stricklin, Herbert L. (Army Engineer Reactors Group, Fort Belvoir, Va.). Mar. 1969. 23p. (ED-6906). CFSTI.

Tables of data collected during the period Jan. 1 to Dec. 31, 1968, and statistical analyses and comparisons with data collected since January 1965, are given. The report concludes that the effect of operation of the SM-1 and MH-1A reactors on the radiological background at Ft. Belvoir, Virginia, is inconsequential. (auth) (USGRDR)

31431 (IS-2025) SURVEY OF ENVIRONMENTAL RADIOACTIVITY. Voss, Milo D. (Ames Lab., Iowa). Jan. 1969. Contract W-7405-eng-82. 40p. Dep. CFSTI.

The environmental radiation monitoring program of the Ames Laboratory is described. The program consists of gross alpha and beta determinations of air, soil, vegetation, river water, Ames Laboratory Research Reactor (ALRR) outfall, bottom sediment, precipitation, well water, and pond samples. The ALRR reached full power as of July 12, 1965 and had generated 43,836 megawatt hours as of Dec. 31, 1967. A total of 26,297 megawatt hours was generated in 1968. The data indicate that the ALRR has not contributed a significant amount of radioactivity to the environment in the Ames area. The conclusion is reached that radioactivity levels recorded for environmental samples represent background conditions from atmospheric fallout and naturally occurring radioactivity. (auth)

31432 (NP-17876) RADIOACTIVE FALLOUT MEASURED AT MOL. Boulenger, R.; de Maere, X. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1967. 97p. (In French). (R-2468). Dep.

The radioactive fallout measured at Mol during 1967 in dusts in suspension in the air and at ground level, in precipitations, and in milk for consumption were reported in the form of tables and graphs. (J.S.R.)

31433 (NSJ-tr-104) SECULAR VARIATION OF ATMOSPHERIC RADIOCARBON CONCENTRATION. Kigoshi, Kunihiko. Translated from Nippon Kagaku Zasshi, 87: 209-20(1966). 26p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 27220.

31434 (UCRL-Trans-10348) STUDIES ON FALLOUT PARTICLES (VIII). Mamuro, Teisuo; Matsunami, Tadao; Fujita, Akira. Translated by T. Ikeda for Univ. of California Lawrence Radiation Lab., Livermore, from Nippon Genshiryoku Gakkaishi, 9: 646-55(1967). 25p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 4284. (R.C.K.)

Mineralogy and Exploration

Refer also to abstract 31482.

31435 (NIM-237) MINERALOGY OF URANIUM IN WESTERN AREAS ORES. von Rahden, H. V. R.; Hiemstra, S. A. (National Inst. for Metallurgy, Johannesburg (South Africa)). Sept. 25, 1967. 11p. Dep.

Ores and slime-fraction concentrates from the Western Areas Mine were examined mineralogically by the electron-microprobe analyser to determine the nature of the uraniferous components present. Apart from uraninite (UO_2), a weakly radioactive mineral identified as uraniferous leucoxene, containing approximately 20% of uranium and 20% of titanium, was found. The uraniferous leucoxene is generally very fine-grained and friable, and would slime readily on being comminuted. The uraniferous leucoxene was probably formed in situ and represents an authigenic component formed as a result of the chemical interaction of rutile and uraninite. It may represent an alteration product of a uranium-titanium mineral. (auth)

31436 DISCOVERY OF URANIFEROUS MINERALIZATIONS IN NIGER. Bigotte, G.; Obellianne, J. M. (CEA, Marseille). Miner. Deposita, 3: 317-33(Dec. 1968). (In French).

The geological framework of the U deposits in Niger, beginning with the initial discovery in the Azelik structure near Agades, is discussed. Three topics are outlined in more detail: tectonic history of the crystalline basement rocks, hyperalkaline volcanism, and the paleoclimate. Volcanism may have existed in the Carboniferous epoch; slowing sedimentation allowed organic material to oxidize. This would contribute to precipitation of U, perhaps by a mechanism similar to that producing the Tarat deltas. Deposition and accumulation of U was mainly controlled by subterranean water. Another area is less well defined with respect to formation and deposition of U, though probably it was furnished by volcanic tuffs. Again organic material controlled deposition and accumulation in a catastrophic period, conceivably in the lower Jurassic period. (BBB)

31437 COMPARATIVE EVALUATION OF SCINTILLOMETRIC, GEOCHEMICAL, AND BIOGEOCHEMICAL METHODS OF PROSPECTING FOR URANIUM. Whitehead, Neil E.; Brooks, Robert R. (Massey Univ., Palmerston North, N. Z.). Econ. Geol., 64: 50-5(Jan.-Feb. 1969).

A number of follow-up prospecting techniques for uranium were used in a uraniferous area of New Zealand. Methods included γ-scintillometry, γ-spectrometry, and the measurement of the α and β activities and uranium content (determined fluorimetrically) of plants and soils. Statistical analysis of the data enabled conclusions to be made concerning the relative value of the various prospecting techniques. It was concluded that fluorimetric analysis of plants and soils, gave the most reliable indication of the presence of uranium in the region. (auth)

31438 POSSIBLE EXPLORATION TARGETS FOR URANIUM DEPOSITS, SOUTH END OF THE URAVAN MINERAL BELT, COLORADO-UTAH. Shawe, Daniel R. (Geological Survey, Denver). U. S., Geol. Surv., Prof. Pap. 650-B, 73-6(1969).

Uranium deposits in Mesozoic sandstone at and near the south end of the Uravan mineral belt, Colorado-Utah, show a preferred association with zones of faults and folds. Here many large deposits in the Salt Wash Member of the Morrison Formation of Late Jurassic age occur near faults associated with collapsed salt anticlines. Unexplored areas within the belt, where favorable strata may exist near faults, are on the northeast side of Disappointment Valley 5 miles east of Slick Rock, Colo., and in a zone extending from Montezuma Canyon, Utah, to the Dolores River Canyon, Colo. Deposits in the Moss Back Member of the Chinle Formation of Late Triassic age are very large and widespread along the Lisbon Valley, Utah, fault and are related to a closed anticlinal structure. Worthy of exploration is another area where favorable host rocks likely occur in a closed anticlinal structure near faults in the vicinity of the Dolores River Canyon, 10 miles northeast of Dove Creek. (auth)

Oceanography

Refer also to abstract 31422.

31439 THE ^{232}Th CONCENTRATION OF SURFACE OCEAN WATER. Kaufman, A. (Lamont Geological Observatory, Palisades, N. Y.). Geochim. Cosmochim. Acta, 33: 717-24(June 1969).

^{232}Th concentrations in surface sea water ranging from 0.3 to 0.6 μg/1000 l have been reported. These estimates were based on the analysis of single samples, the work described is based on a composite of 24 analyses of water collected from widely spaced parts of the ocean. A careful interpretation of the alpha spectrometer data indicates that the true concentration is less than 0.07 μg ^{232}Th/1000 l. (auth)

31440 SORPTION EXPERIMENTS OF STRONTIUM, CESIUM, AND PROMETHIUM, AND EUROPIUM ON MARINE SEDIMENT SAMPLES. Cerrai, E. (CISE, Milan); Mezzadri, M. G.; Triulzi, C. Energ. Nucl. (Milan), 16: 378-85(June 1969).

Radioactive strontium, cesium, promethium, and europium solutions in sea water or salt environments were contacted with marine sediment samples to determine activity percent uptake and distribution coefficients in batch experiments. Activity percent uptake was measured as a function of sediment weight up to 200 mg. Sorption appreciably increases in the order: strontium, cesium, rare earths. Leaching experiments were also carried out to evaluate the extent of radioactivity release in the case of cesium, promethium, and europium contaminated sediments. The radioactive isotopes used were: ^{137}Cs, ^{89}Sr, ^{147}Pm, and ^{152}Eu. (auth)

Seismology

Refer also to abstracts 31443 and 31444.

31441 (CEA-R-3736) CALCULATION OF THE SHOCK-WAVE IN THE REGION CLOSE TO AN UNDERGROUND NUCLEAR EXPLOSION (METHOD CADES). Supiot, Francis; Brugies, Jacques (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Apr. 1969. 25p. (In French). Dep.

The outline of a method is presented for calculating the characteristics of a shock wave produced by an underground nuclear explosion (pressure, wave velocity, velocity of the medium, energy left in the medium by the shock, etc.). By means of an application to a granitic medium and of a comparison with results obtained during French nuclear explosions, it was possible to show good agreement existing between the calculations and the experimental results. The advantages of such a method for studying the industrial applications of underground nuclear explosions are stressed. (auth)

31442 SEISMIC EVENTS ORIGINATING AT THE ATOMIC ENERGY COMMISSION'S NEVADA TEST SITE. Krivoy, Harold L.; Mears, Connally E. (Geological Survey, Flagstaff, Ariz.). U. S., Geol. Surv., Prof. Pap. 650-B, 117-21(1969).

Underground nuclear explosions at the Nevada Test Site (NTS) have been detected at a Flagstaff, Ariz., geophysical observatory since November 1966. Data on these man-made seismic events (shotpoint coordinates, shot times, and phase arrival times) were used to calculate a thickness of about 36 km for the crust between Flagstaff and the NTS. From the data of other observatories, as compiled and published by the U.S. Coast and Geodetic Survey, relationships are inferred which show a pattern of aftershocks following certain of the tests at the NTS. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 31417 and 31441.

31443 (CEA-Bib-152) PEACEFUL USES OF NUCLEAR EXPLOSIONS: GEOLOGY, SEISMOLOGY, BEHAVIOR OF SOILS AND ROCKS. Berton, Micheline (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Apr. 1969. 200p. (In French). Dep.

This literature survey consists of 754 complementary references. The documents are classified into four categories: general considerations, contained explosions, seismology, behavior of soils, rocks, and underground water during nuclear explosions or under conditions of very high pressure or temperature. The references are listed chronologically. (auth)

31444 (NVO-1163-138) EFFECT OF GROUND MOTION ON SEDAN CRATER SLOPES FROM AN UNDERGROUND NUCLEAR EXPLOSION IN THE VICINITY. Smith, Sherwood B. (Environmental Research Corp., Alexandria, Va.). May 1, 1969. Contract AT(29-2)-1163. 57p. Dep. CFSTI.

Predicted slides from earthquake ground motions and slides from ground motions caused by underground nuclear detonations are studied on Sedan Crater slopes comprised of granular material. Measured transient ground replacements were used in calculating downslope displacements instead of developing them from acceleration measurements. Slopes in lower portions consisted of fallback material at about a 35° angle of repose. Walls of the true crater comprised the upper third of the slopes. (J.C.W.)

31445 (PNE-R-1) PROJECT RULISON: A GOVERNMENT-INDUSTRY NATURAL GAS PRODUCTION STIMULATION EXPERIMENT USING A NUCLEAR EXPLOSIVE. (Project Rulison Joint Office of Information). May 1, 1969. 12p. Dep. CFSTI.

Project Rulison calls for a fully contained 40 kiloton nuclear explosion buried in the Mesaverde Formation at 8430 ft below the surface to release gas from the deep "tight" gas bearing formation. The project will demonstrate the potential of nuclear stimulation for commercial development in the Rulison Field and other locations. The project background, objectives, experimental details, safety and participants are summarized. (F.S.)

31446 (UCRL-71659) MASS EXTRACTION RATES OF RADIONUCLIDES IN FALLOUT MATERIAL FROM A 170-kt NUCLEAR CRATER. Fleming, E. H. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 18, 1969. 29p. (CONF-690406-11). Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

The quantity k is defined as the fraction of a nuclide in the environment which must be ingested each day over a given time period to receive a maximum allowable dose, in accordance with the International Commission on Radiological Protection guidelines. Values of k were computed for radionuclides produced in a single cratering detonation using current design technology. A new concept called the "Mass Extraction Rate" is presented. This concept is defined as the mass of earth material from which the entire quantity of the radionuclide must be extracted and ingested each day by some natural process over a given time interval, which results in a permissible dose. Mass Extraction Rate values are tabulated. A comparison is made between the Mass Extraction Rate and the specific activity methods. (auth)

Facilities and Equipment

Refer also to abstracts 31465, 31472, 31508, 31509, 31576, 31577, 31593, 32028, 32047, 32207, 32267, and 32277.

31447 (CEA-Bib-140) SPACE PROPULSION (MODERN PROPULSION PROCESSES). Pabot, Jean-Louis (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1969. 43p. (In French). Dep.

A review is presented of non-chemical propellants used in space propulsion. The characteristics of the rocket motor are first given, followed by a description of the propulsion methods studied in the laboratory; particular attention is paid to nuclear and ionic propellants. In conclusion, it appears that chemical, nuclear, and electrical means of propulsion are complementary; each can be suitable for a particular job in space. (auth)

31448 (CEA-R-3734) INSTALLATION OF A BITUMEN COATING PLANT FOR HIGH-ACTIVITY CONCENTRATES. Rodier, Jean; Lefillatre, Guy; Seyfried, Philippe (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Apr. 1969. 22p. (In French). Dep.

With excellent results obtained on the industrial coating of radioactive sludges, the possibility of solidifying the evaporation concentrates with bitumen was considered. For high activity concentrates, the use of bitumen is limited by temperature and radiation resistance. By making use of the characteristics of a blown bitumen, it was possible to design a high activity coating pilot plant treating concentrations of several tens of curies per liter. The plant will make use of a screw-type extrusion machine capable of coating treated concentrates at a rate of 20 l/hr. Before being coated, the concentrates will be subjected to a coprecipitation treatment designed to make the radioelements insoluble. The installation will make possible laboratory experiments on the coated material (measurements on self-heating, on electrical charges, on radiolytic gases, and also lixiviation tests). On the basis of available data, it is possible to coat concentrates having an activity of 20 Ci/l at a price of 1840 francs per cubic meter. (auth)

31449 (DUN-5767) ENGINEERING REPORT: STABILITY OF CRW PUMP MOTORS DURING BPA TRANSIENT POWER CONDITIONS. Thorson, W. R. (Douglas United Nuclear, Inc., Richland, Wash.). Apr. 28, 1969. 15p. Dep. CFSTI.

The inadequacy of the present relay protection for the 3500 hp synchronous motors during transient power conditions is described and functional requirements for a relay system that will protect the motor during BPA transient faults are described. (F.S.)

31450 (EUR-4217) EUREX EURATOM-CNEN AGREEMENT. Annual Report, 1967. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 48p. (In Italian). Dep.

The construction, operation, and use of the Eurex plant for industrial research purposes are described. The design and construction of the plant are discussed. The laboratory and pilot scale tests and experiments conducted prior to the start of the plant operation are described. The operation of the fuel element storage pool is outlined. (tr-auth)

31451 (UCRL-50634) NONGASEOUS RADIOISOTOPES: PROJECT GASBUGGY CHIMNEY GAS. Smith, Charles F. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 7, 1969. 8p. (PNE-G-45). Dep. CFSTI.

The possibility that Project Gasbuggy chimney gas might contain volatile organometallic or hydride compounds of fission product iodine, antimony, tin, tellurium, and ruthenium has been investigated. No evidence for the presence of any gamma-emitting radionuclides was found except for rare gases. Assuming 0.1 times background as a detection limit, experimental upper limits for these radionuclides in the chimney gas have been established. Probable upper limits based upon the ^{131}I experimental value of 0.04 pCi/cc (STP) at the time of detonation have been calculated for these species as well as for ^{90}Sr and ^{137}Cs. These upper limit values are considered low enough to obviate further investigation and to pose no problem during the Gasbuggy experimental program. (auth)

31452 (UCRL-50635) PROJECT GASBUGGY GAS QUALITY ANALYSIS AND EVALUATION PROGRAM TABULATION OF RADIOCHEMICAL AND CHEMICAL ANALYTICAL RESULTS. Smith, Charles F. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 22, 1969. 19p. (PNE-G-44). Dep. CFSTI.

Analytical results for samples of Project Gasbuggy chimney gas have been distributed to project participants and the interested public. This tabulation summarizes the previous results with a consistent up-to-date listing of samples, radionuclide concentrations, and chemical analysis results. The listing includes the description and the disposition of all samples obtained for analysis at the Lawrence Radiation Laboratory following the Gasbuggy detonation. Radiochemical results expressed as concentrations in chimney or formation gas are given for ^{85}Kr, HT, HTO, CH_3T, C_2H_5T, C_3H_7T, $^{14}CO_2$, ^{37}Ar and ^{39}Ar. Upper limits for the concentrations of several nongaseous or semivolatile nuclides are presented. The tabulation also includes the percentages of N_2, CO_2, CO, H_2, CH_4, C_2H_6 and C_3H_8 in the sample gas as determined by mass spectrometry. (auth)

31453 THE U. S. URANIUM ENRICHMENT INDUSTRY. Benedict, Manson (Massachusetts Inst. of Tech., Cambridge). Chem. Eng. Progr., 65: No. 6, 83-6(June 1969).

The uranium enrichment industry in the U. S. is discussed. The government-owned plants are being considered for sale to private

companies. The increased demand for separative work is formulated with projected needs. Problems involved in the private ownership of the enrichments plants and possible solutions are presented. (J.C.W.)

31454 PLUGS OR SIMILAR CLOSING ELEMENTS. Le Polles, Robert; Peyrot, Jean Pierre; Schley, Robet (to Commissariat a l'Energie Atomique). British Patent 1,154,088. June 4, 1969. Priority date Sept. 9, 1965, France.

Plugs or closures for capsules used to hold materials to be irradiated are described. The plugs are designed to hold and support thermocouple leads and consist of a body formed in two parts which fit together and define a chamber. Bores in the body allow thermocouple leads to be passed through the closure to the chamber and provide communication between the exterior of the body and the chamber. When the leads are in place, a passage for admitting brazing material is available. Discs are also provided to help support the thermocouple leads. (F.S.)

31455 MULTI-BEARING STEAM TEST RIG (Engineering Materials). (Mechanical Technology Inc., Latham, N. Y). (CAPE-1882).

79 drawings.

A multi-bearing rotor system wherein the rotor is supported entirely by steam-lubricated bearings is described. The system consists of the rotor with two externally pressurized steam-lubricated journal bearings and one thrust bearing which is also steam lubricated and externally pressurized to support the position of the rotor. The steam lubricant drives and rotates the shaft at speeds from several hundred to 7500 rpm. (For details see TID-4100 Suppl. 53). (See also 23: 2463). (F.S.)

31456 DEVICE FOR HERMETICALLY CLOSING A NUCLEAR REACTOR FUEL ELEMENT. Droussent, Roger; Houyvet, Alain (to Commissariat a l'Energie Atomique). British Patent 1,154,780. June 11, 1969. Priority date May 3, 1967, France.

A quick-action hermetic closure device used to seal a reactor fuel element in a tubular can is described. The device consists of a soft-metal annular bearing surface secured to or integral with the can, a hard metal plug holding a knife blade opposite the bearing surface, and means for clamping the plug on the bearing surface until the blade is embedded in the surface. The hard metal plug consists of a cylindrical closure part placed inside the annular bearing surface and extended laterally by a peripheral lip which holds the blade above the bearing surface. A smooth cylindrical wall extends around the bearing surface with a small amount of clearance. (F.S.)

31457 IMPROVEMENTS RELATING TO THE CONTROL OF LIQUID METAL FLOW. Hackney, Stanley; Davidson, Daniel Fraser (to United Kingdom Atomic Energy Authority). British Patent 1,153,494. May 29, 1969. Filed July 22, 1966.

Apparatus is described for testing for the occurrence of fuel element sheath failure in liquid cooled reactors. The apparatus comprises a fission product detecting chamber, sampling pipes for liquid metal coolant leading to this chamber, and associated with each sampling pipe is an electromagnetic device, operable selectively, for altering flow impedance as the liquid metal flow in the pipe is controlled. Each sampling pipe may be branched so that flow can continue if flow is prevented in one branch, by diversion to the other branch. Several other variants are also described. The apparatus consists essentially of electromagnetic pumps or brakes, and the latter may also act as flowmeters. (UK)

31458 IMPROVEMENT IN VAPOUR SEPARATION FROM CIRCULATING LIQUID. (to Institutt for Atomenergi). British Patent 1,153,718. May 29, 1969. Priority date June 29, 1965, Norway.

A method and apparatus are described for separation of entrained vapor bubbles from a fluid which is a liquid-vapor mixture. The fluid is continuously circulated in a closed path. Part of the path ascends through a source of heat and part descends which causes natural separation of the larger bubbles. Centrifugal separation underneath the fluid surface at the upper end of the descending path separates the smaller bubbles. (F.S.)

31459 SEPARATION OF THE CORE OF A URANIUM FUEL ELEMENT FROM ITS ENVELOPE. Raviv, Samuel; Rabinovitz, Elsa; Malkiely, Shimon (to Ministry of Defence). U. S. Patent 3,446,713. May 27, 1969. Filed Sept. 26, 1967.

The core of a uranium fuel element with exposed ends is separated from its envelope by using the core as a cathode and connecting it into an electrolytic circuit in which the electrolyte is 7 to 12N nitric acid. Electrolysis is continued until the core is free of the envelope. The envelope is then removed. (Offic. Gaz.)

31460 IMPROVEMENTS IN OR RELATING TO TUBULAR HEAT-EXCHANGERS. (to Fives-Penhoet). British Patent 1,154,944. June 11, 1969. Priority date May 27, 1966, France.

A tubular heat exchanger is described which consists of a number of mutually adjacent elongated cells forming individually prismatic ducts for a fluid to be heated and housing individual nests of tubes which circulate a heat carrying fluid. The wall of each cell has flat portions coextensive with flat wall portions of adjoining cells. The heat exchangers are used in pressure vessels containing a reactor and are located either above or at the side of the reactor. (F.S.)

31461 MULTI-WAY SELECTOR VALVES. Rue, Raymond William (to English Electric Co., Ltd.). British Patent 1,148,861. Apr. 16, 1969. Filed Mar. 29, 1966.

Reference is made to rotor operated multi-way selector valves. The valve described includes an indexing member disposed in the housing radially with respect to the rotor rotation axis, and provided with a piston means subjected to a controlling fluid pressure for moving the indexing member backwards and forwards along a radial path with respect to the rotation axis. The indexing member has a pair of mutually opposed fixed ratchet teeth spaced at different distances from the rotation axis and offset from each other, in a direction perpendicular to the radial path, by half the circumferential distance between the axes of two adjacent housing ports along a pitch circle, and the rotor has a plurality of axial projections for engaging the teeth. The arrangement is such that one movement of the indexing member causes the rotor to rotate from one position to the next. The valve may incorporate a number of spring-loaded graphite sealing bushes to provide sealing between each housing port and the rotor passage. Such valves are stated to be suitable for use as secondary selector valves in nuclear reactor burst cartridge detection systems. (UK)

31462 NUCLEAR POWER GENERATION AND PETROLEUM REFINING. Takei, Mitsuo. Sekiyu Gakkaishi, 11: 925-8(Dec. 1968). (In Japanese).

The amount of nuclear electric power generated in the long term planning of power generation up to 1985 is estimated. The decreasing consumption of heavy oil for electric power and future problems in the petroleum refining industry in Japan were studied. In 1985, the amount of nuclear power generation will reach about 54 million kW and its generation cost will be about 1.70 yen/kWh for a single plant of a million kW capacity. Economical predominance is expected in comparison with the cost of 2.30 to 2.40 yen/kWh for a million kW scale plant of steam generation with heavy oil. As for the trend up to 1985, the change in demand for petroleum products, that is, the decreasing ratio of heavy oil and the increasing ratio of light oil plus naphtha will appear. The countermeasures corresponding to the above changes of demand are discussed from the standpoint of the petroleum refining industry. It was concluded that the development of nuclear power generation not only affected the technologies of electric power generation, but promoted the progress of technologies utilizing fossil fuels. (NSA of Japan)

31463 DESIGN OF THE HIGH TENSION CIRCUIT IN AN ATOMIC POWER STATION USING A COMPUTER. Ito, Takahiko. Chubu Denryoku K. K. Kenkyu Shiryo, No. 42, 122-6(Dec. 1968). (In Japanese).

A 6.6 kV circuit in an atomic power station was designed with the UNIVAC 1108, employing Inukai's "Design method for the high tension circuit in a thermal power plant." To obtain the permissible % impedances for the direct transformer, the input of load induction motors and the input of the maximum induction motor were used. The following parameters were used: metal-clad switch gear magnetic circuit breaker, capacity of a direct transformer, direct transformer division, maximum induction motor division, and the maximum induction motor initial transient % reactance. The range of the permissible impedances was obtained in 14 seconds. (NSA of Japan)

Heat Transfer and Fluid Flow

Refer also to abstracts 31457, 31458, 31460, 31497, 32206, and 33052.

31464 (AERE-M-2152) MINIMUM FLUIDISATION VELOCITIES FOR SPHERICAL AND IRREGULAR PARTICLES FLUIDISED BY AIR. Partridge, B. A.; Lyall, E. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 21p. Dep. CFSTI. UK 4s. 0d.

The minimum fluidization velocity and bed voidage were measured for shallow beds of closely sized glass spheres and irregular sand particles in the range 3000 to 60 μm fluidized by air. The observations with glass spheres were consistent with the Kozeny–Carman equation for flow through packed beds of spheres, and at minimum fluidization gave a mean value of the Kozeny constant very close to the generally accepted value of 4.8 which has been

found to apply to beds in which the spheres are randomly packed. (auth)

31465 (AERE-M-2175) THE LOTUS (LONG TUBE SYSTEM) AIR-WATER LOOP DESIGN AND DESCRIPTION. Roberts, D. N. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1969. 21p. Dep. CFSTI. UK 3s. 6d.

The LOTUS loop has been operating at Harwell for over five years and a wide range of experimental work has been performed on it. The main object of the rig was to allow the study of vertical two-phase flows in channels of long length (the maximum length is 77 feet). Background information on the loop is presented, which supplements that given in individual reports on the experimental work. (auth)

31466 (AERE-R-6012) STUDIES OF THE BEHAVIOUR OF DISTURBANCE WAVES IN ANNULAR FLOW IN A LONG VERTICAL TUBE. Gill, L. E.; Hewitt, G. F.; Roberts, D. N. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 22p. Dep. CFSTI. UK 3s. 6d.

Measurements of the velocity and frequency of disturbance waves in vertical upward annular flow were made for a variety of gas velocities and pressures at a number of distances from the liquid injection point ranging up to 55 ft. It was shown that, for a given distance between the injector and the measurement point, the wave frequency and velocity were independent of the length for gas flow upstream of the injector and the length for two phase flow downstream of the injector. This confirmed the reproducibility of the wave phenomenon and eliminated one possible source of inconsistency in area data. It was also shown that the wave frequency and wave velocity became constant, independent of the distance from the liquid injector, if the distance was great enough; thus, the frequency and velocity showed no significant change in the distance range 30 to 55 ft. It was found that, for a given gas velocity, both wave frequency and wave velocity increased with increasing gas density. Experimental work described was carried out using air–water flow in a vertical 1.25 in. bore tube. Entrainment, film thickness and pressure gradient data were obtained and are given for reference purposes. (auth)

31467 (AERE-Trans-1092) EXPERIMENTAL STUDY OF FORCED-CONVECTION HEAT TRANSFER BY LIQUID SODIUM IN A CYCLINDRICAL TUBE HEATED AT A CONSTANT DENSITY OF THERMAL FLUX. Brachet, A.; Lannou, L. Translated by T. O. Lazarides (Atomic Energy Research Establishment, Harwell, Eng.), from Bull. Cent. Rech. Essais Chatou, No. 14, 17-50(1965). 36p. Dep. CFSTI. UK 5s. 0d.

This investigation was carried out with a stainless steel tube with a circular cross-section at a fully established hydraulic regime. Measurements were made at distances varying from 20 to 45 diameters from the beginning of the heated sections. The heated wall temperatures were measured with wall thermocouples. The results obtained were found to follow the formula $Nu = 5.29 + 0.0068\ Pe^{0.93}$, and are in good agreement with known data. The presence of sodium oxide seems to have had no effect. The main experimental parameters were varied in the following ranges: ϕ: 50–320 W/cm^2 (mean thermal flux density over length L); V: 0.80–15.2 m/sec (mean velocity of Na); t^0: 130 to 320°C; Δt: 6.4 to 36°C (temperature drop between heated wall and Na); Pe: 125 to 2270 (Péclet number); Re: 17,000 to 340,000 (Reynolds number); Pr: 0.00576 to 0.00784 (Prandtl number); and Nu: 5.7–15.8 (Nusselt number). (auth)

31468 (BNL-tr-267) HYDRODYNAMICS OF A TWO-PHASE FLOW OF POTASSIUM IN TUBES. Aladev, I. T.; Goriov, I. G.; Dodonov, L. D.; Fedynskii, O. S. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from pp 3-18 of Gidrodynamika Dvukhsazovogo Potoka Kaliya v Grubakh, Nauka, Moscow, 1968. 34p. Dep. CFSTI.

The true volume vapor quality and hydraulic resistance for adiabatic flow of potassium vapor in tubes are reported. The difference in the physical properties of the vapor and liquid phases and the flow dynamics determine the relative velocity of the phase, i.e., the slip. Characteristics of the slip were studied experimentally by measuring the true volume vapor quality of the flow. Semiempirical equations are derived for the calculations of the true vapor quality and the resistance of the K vapor flow. (J.C.W.)

31469 (CEA-R-3599) EXPERIMENTAL STUDY OF HEAT TRANSFER FOR PARALLEL FLOW IN TUBE BUNDLES WITH CONSTANT HEAT FLUX AND FOR MEDIUM PRANDTL NUMBERS. Rieger, Manfred (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 115p. (In French). (EUR-3879). Dep.

Thesis. Submitted to Univ., Paris.

Heat transfer parameters were determined experimentally in electrically heated tube bundles for turbulent flow parallel to the axis. The tubes were arranged in a pattern of equilateral triangles. The ratios of the distance between the axes of the tubes to their external diameter were 1.60 and 1.25 in the two test sections studied. The experiments were carried out with distilled water and with a mixture of 60% ethylene glycol and 40% water. The values obtained for the Prandtl numbers fell within the range from 2.3 to 18. The Reynolds numbers were varied between 10^4 and 2.10^5. The relation between the mean heat transfer coefficients and the friction factor in the tube bundles was found from the experiments. The experimentally determined mean Nusselt numbers were given by the function: $Nu = [0.0122 + 0.00245\ (p/d)]\ Re^{0.86} \times Pr^{0.4}$ with a maximum deviation of ±4%. (auth)

31470 (EUR-4241) FRANCESCA: DYNAMIC PROGRAM FOR BOILING COOLING CHANNELS. Forti, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 49p. Dep.

The Fortran program FRANCESCA for IBM 360 is a dynamic code for boiling channels. The physical model is one-dimensional, and includes subcooled boiling and optionally superheating of the liquid in the bulk boiling zone. The finite difference method of calculation is employed, with up to 100 mesh points in the active part of the channel and 10 more points in the riser. The program is intended for forced circulation and highly pressurized systems, for which the pressure drop in the channel may be considered negligible compared to the general pressure level, so that the coolant fluid properties may be assumed independent of space and time. The driving pressure may be taken as a quadratic function of the mass flow, to simulate pump characteristics or given as a time table. The power distribution in the heating element is given as a fixed arbitrary shape, while the power level is any tabulated function of the time. (auth)

31471 (EURAEC-1090) TWO-PHASE (GAS + LIQUID) ADIABATIC VERTICAL UP-FLOW: A PRELIMINARY STUDY WITH A ROD CLUSTER GEOMETRY. Topical Report No. 19. Alia, P.; Cravarolo, L.; Hassid, A.; Pedrocchi, E. (Centro Informazioni Studi Esperienze, Milan (Italy)). Mar. 1968. Contract 060-61-7-RDI. 82p. (EUR-3997; CISE-R-108). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The hydrodynamics of two-phase (gas–liquid) systems in annular-dispersed flow with a rod bundle geometry was investigated. The thickness of the film region at the pressure tube and rod walls and the pressure drop and density were investigated. A schematic flowsheet of the testing circuit is given. (J.C.W.)

31472 (GAMD-8766) EXPERIMENT ON GAS MIXING IN A CROSS-FLOW TUBE BUNDLE. Efferding, L. E.; Landa, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 15, 1969. Contract AT(04-3)-633. 60p. Dep. CFSTI.

Tests were performed to determine the amount of gas-side mixing between a hot gas stream and the ambient flow during cross-flow through an in-line bundle; excess flow (gas bypass) around the tube bundle via the channel between the outside row of tubes and the wall; and the effectiveness of the tube bundle in uniform flow resistance in smoothing inlet gas velocity distortions. Significant levels of gas mixing during cross-flow were measured. A nominal mixing coefficient of 0.10 was indicated at the steam generator operating Reynolds number of 40,000. Problems in steam generator such as operating with plugged tubes are eased when the mixing effect is considered. Gas bypass around the tube bundle along the wall is negligible. Several inlet velocity distortions introduced to the test bundle were smoothed after six rows showing that the tube bundle acts as an effective screen. The reheater bundle should smooth any inlet gas velocity streaks. A flow anomaly which affects the exit velocity profile appears to be a characteristic common to cross-flow geometry. (F.S.)

31473 (RD/B/N-1278) VELOCITY MEASUREMENTS IN ROUGHENED ANNULI. Lawn, C. J.; Hamlin, M. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb. 1969. 27p. Dep.

Velocity measurements in two annular test sections containing ribbed surfaces are related to the wall shear stresses. These were determined by location of the zero shear stress surface with a hot wire probe, and from the pressure gradient. Results confirm an earlier conclusion, based on a roughened pipe experiment, that the flow over a ribbed surface is influenced by viscosity. The nature of this influence is obscured by the scatter in the results, thought to be due to unintentional variations in rib profile from one surface to another. A method of predicting friction factors based on these results is described, and conclusions are drawn as to the effect of the geometry of the test section. (auth)

31474 (ZJE-29) INTERACTION OF THERMAL RADIATION WITH FREE CONVECTION HEAT TRANSFER IN A CLOSED CAVITY. Pecinka, Ladislav (Skoda [Works], Pilsen (Czechoslovakia). Nuclear Power Plant Div.). Oct. 1968. 18p. Dep.

The effects of thermal radiation on natural convection heat

transfer in a gas-cooled, heavy-water moderated reactor with a vertical arrangement of pressure tube channels were analyzed. The conductive and laminar heat transfer regimes were studied for an analysis of the insulation provided by a gas layer of a multilayer region. The conductive regime of the lowest losses by heat dissipation into the moderator was studied at $t \sim 0.2$ mm for insulating gas with normal parameters. For currently used thickness of insulating space, the laminar conductive regime was attained. The conductive regime was presumed to be in individual layers. Based on the knowledge of the temperature profile of layers, the radiation flux may be determined. (F.S.)

31475 INCIPIENT BOILING SUPERHEAT IN LIQUID METALS. J. Heat Transfer, 91: 198-202(Feb, 1969).

A paper published by J. C. Chen in the August, 1968 issue of the Journal of Heat Transfer and abstracted in NSA 22: 49020 is discussed. Comments are made on the change in geometry from a conical to cylindrical vessel, the practically constant superheat, validity of the Holtz theory, oxide effect, data points for deactivation, and the assumption of a negligible amount of inert gas depletion from surface cavities by diffusion into the liquid. (F.S.)

31476 EFFECT OF CONTAINER CAPACITANCE ON THERMAL TRANSIENTS IN PLANE WALLS, CYLINDERS, AND SPHERES. Myers, G. E.; Kotecki, D. J. (Univ. of Wisconsin, Madison). J. Heat Transfer, 91: 67-72(Feb, 1969).

The effect of container capacitance on the thermal response of plane walls, infinite cylinders, and spheres subjected to sudden changes in ambient temperature is analyzed. A series solution is presented for each geometry which can be obtained by the method of separation of variables. The first three eigenvalues necessary for the numerical evaluation of the series are tabulated for each configuration. Analytical curves are presented which enable the engineer to determine whether the exact solution must be used or whether an additional approximation can be made which allows a simplification to results commonly found in heat transfer textbooks. (auth)

31477 HEAT TRANSFER TO CARBON DIOXIDE IN THE IMMEDIATE VICINITY OF THE CRITICAL POINT. Schnurr, N. M. (Los Alamos Scientific Lab., N. Mex. Vanderbilt Univ., Nashville). J. Heat Transfer, 91: 16-20(Feb. 1969).

Local heat-transfer coefficients were measured for carbon dioxide very near the thermodynamic critical point for flow through an electrically heated circular duct. The experiments cover a range of fluid bulk temperatures spanning the transposed critical temperature and of pressure from 1075 to 1110 psia (reduced pressure from 1.003 to 1.03). The data are correlated by the equation $Nu_z = 0.0266\ Re_z^{0.77}\ Pr_w^{0.55}$ where the Prandtl number is evaluated at the wall temperature and Nusselt and Reynolds numbers are evaluated at a variable reference temperature. The dominant heat transfer mechanism is found to be turbulent forced convection. There is evidence that free convection effects are also present. (auth)

Isotope Technology

Refer also to abstracts 31400, 31493, 31573, and 31578.

31478 (CONF-681032) ^{252}Cf. Proceedings of a Symposium, New York City, October 22, 148. Barker, James J. (ed.) (Long Island Univ., Greenvale, N. Y. C. W. Post Coll.). Jan. 1969. 396p. Dep. CFSTI.

Sixteen papers presented at the symposium are included. Separate abstracts were prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 31298, 31359–31363, 31399, 31479–31482, 31748, 31859, 32076, 32925, and 32926.

31479 (CONF-681032–, pp 1-9) ^{252}Cf: RADIOISOTOPE WITH A FUTURE. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.).

The properties and uses of ^{252}Cf are described. Discovery of the isotope and methods of its production are reviewed. Medical applications of the isotope, its use in prospecting for important minerals and as a neutron source in research and teaching, and industrial applications are discussed. Analytical procedures using ^{252}Cf are considered. (M.C.G.)

31480 (CONF-681032–, pp 225-56) SURVEY OF APPLICATIONS FOR ^{252}Cf. Crandall, J. L. (Du Pont de Nemours (E. I) and Co., Aiken, S. C. Savannah River Lab.).

One gram of ^{252}Cf emits 2.34×10^{12} neutrons/second from a volume of less than 1 cc with a heat production of less than 40 watts and a half life (α + spontaneous fission) of 2.6 years. Although ^{252}Cf will always be relatively expensive, because of its high average neutron yield per radioactive disintegration it produces neutrons less expensively than any comparable radioisotope source and competitively with small nuclear reactors and accelerators. It thus has major potential in providing compact, portable, and reproducible neutron sources at intensities ranging from a few neutrons/second up to 10^{14} neutrons/second. Such sources have unique applications as tissue implants for cancer therapy, as point sources for neutron radiography, and as portable tools for mineral exploration, as well as meeting more specialized purposes such as reactor physics measurements. Other uses of the ^{252}Cf sources are expected in such fields as activation analysis, short-lived radioisotope production, moisture gages, well logging, and in-line process instrumentation, where the operating simplicity, minimal maintenance, and full predictable output of these sources should open many applications which are currently closed to the more conventional accelerator and reactor sources. Particular emphasis is being placed on industrial uses of the ^{252}Cf sources for in-line process control. A preliminary market survey of possible ^{252}Cf applications indicates a demand for 20 to 60 g of ^{252}Cf by 1975, with the probability of an exponentially increasing demand for some time thereafter. (auth)

31481 (CONF-681032–, pp 303-19) FORSEEABLE APPLICATION OF ^{252}Cf TO NEUTRON RADIOGRAPHY. Barton, J. P. (Argonne National Lab., Ill.).

The future demand for ^{252}Cf as a neutron source for radiography is evaluated. Applications for small-source neutron radiography include direct exposure to thermal neutrons, gamma insensitive exposure to thermal neutrons, and fast neutron radiography. The complementary and competitive uses of ^{252}Cf for neutron sources are discussed. (J.C.W.)

31482 (CONF-681032–, pp 321-46) USE OF ^{252}Cf FOR MINERAL EXPLORATION: COMPARISON WITH ACCELERATORS FOR IN SITU NEUTRON ACTIVATION OF SILVER. Senftle, F. E.; Philbin, P. W.; Sarigianis, P. (Geological Survey, Washington, D. C.).

Techniques for using accelerators and californium-252 as neutron sources for in situ neutron activation of silver ores followed by detection with a gamma ray spectrometer are described. Gamma spectra of similar silver ores are compared and the advantages and disadvantages of each type of neutron source are discussed. ^{252}Cf is particularly suitable for borehole exploration. (auth)

31483 (JPRS–47922) RADIOISOTOPE PRODUCTION AND APPLICATIONS. Translated from At. Energ. (USSR), 26: 122-7; 169-75(1969). 22p. CFSTI.

Uses of radioisotopes in the USSR in food preparation; gaging; nondestructive testing; and in cement, chemical, metallurgical, mining, and textile industries are described. The applications of thermoelectric generators for low power independent electric sources for powering equipment in satellites, space stations, navigational and oceanographic devices are discussed with special emphasis on generators using ^{144}Ce, ^{137}Cs, ^{242}Cm, ^{238}Pu, and ^{90}Sr. (F.S.)

31484 (SC-ARPIC-1011) SELECTED THERMOELECTRIC, THERMIONIC, AND ELECTRON-VOLTAIC ENERGY CONVERSION DEVICE CHARACTERISTICS. Gerwin, H. J. (comp.) (Sandia Labs., Albuquerque, N. Mex.). May 1969. 27p. Dep. CFSTI.

Information on thermoelectric, thermionic, and electron-voltaic energy conversion devices that are commercially available or are in the prototype stage of development is presented. Included are certain devices for use in space, terrestrial, and marine environments. Technical data, applications of devices, and general cost information are included. (auth)

31485 (UCRL–50007-68-3, pp 53-8) RESULTS OF PARTICIPATION IN AN IAEA ENVIRONMENTAL SAMPLE INTERCOMPARISON. Griffith, R. V. (California Univ., Livermore. Lawrence Radiation Lab.).

Results are presented from an IAEA environmental sample intercomparison measurements of the activities of ^{137}Cs and ^{40}K in animal material, ^{40}K in feldspar, ^{222}Rn in water, and ^{226}Ra and ^{228}Ra in soil. (B.G.D.)

31486 (WANL–3800-28) SNAP 23A, PHASE 1. Quarterly Progress Report, December 1, 1968–February 28, 1969. Wilgus, W. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Mar. 20, 1969. Contract AT(30-1)-3800. 117p. (WANL-PR-SS-25). Dep. CFSTI.

The use of $SrTiO_3$ fuel capsule instead of an electrical heater in the PMS was recommended. Thermal and mechanical tests of the EMS have been completed. The Fueled Prototype Mockup System (FPMS) design is being reviewed and materials selection begun. The (F)PMS/PMC-2 design point selection was made corresponding to a maximum BOL hot junction temperature of 1040°F with an increase in ambient temperature capable from 70 to 100°F in this design. Data are presented for the spherical insulation tests using Min-K 2000 and Min-K 2002. Thermal grease testing

results are given. Safety analyses, specifically on the loss-of-radiator accident, on internal heat source material requirements were investigated. (J.C.W.)

31487 PRODUCTION OF THIN TRITIUM SOURCES BY GLOW DISCHARGE. Daris, R.; St Pierre, C. (Laval Univ., Quebec). Nucl. Instrum. Methods, 71: 187-8(1969).

Very thin tritium sources were prepared by glow discharge in tritium with aluminum electrodes. Although about 60% of the total activity originates from tritium absorbed on the surface, these sources are very stable under vacuum. When most of this absorbed gas was removed by immersion in water, still 90% of the remaining activity was found to be in a thickness of less than 3 $\mu g/cm^2$. (auth)

31488 β-RAY RADIATING SOURCE AND METHOD OF PREPARING SAME. Adam, Laszio; Galcso, Istvan (to Banyaszati Kutato Intezet). British Patent 1,154,344. June 4, 1969. Priority date May 25, 1965, Hungary.

A β source is described and the method for its preparation given. The source consists of a layer of enamel containing a β-emitting substance such as $^{90}Sr/^{90}Y$, ^{147}Pm, or ^{204}Te, applied on a base plate. There must not be any material in the base plate or the enamel which has a higher atomic number than silicon, except for the β-emanating radioisotope. This reduces the x-ray bremsstrahlung to a minimum. (F.S.)

31489 CALIBRATION FOR GAMMA RADIATION DETECTION INSTRUMENTS. Lindbeck, S. L. (NUS Corp., Washington, D. C.); Steigelmann, W. H.; Williams, E. F. Jr. Nucl. Eng. Design, 9: 311-14(Mar. 1969).

A device for precise calibration of gamma radiation detection instruments is described. The new calibrator will be a primary standard for a nationwide radiobiological instrument maintenance and calibration program. The calibrator's 500-Curie, $^{137}Cs-^{137}Ba$ source gives a uniform beam over a range of dose rates of 0.002 to 500 R/hr. Motor driven, tungsten alloy shutters, controlled either manually or by an electric timer, permit three beam intensities: 1/1000, 1/50, or full. Leakage with all shutters closed is less than 2 mR/hr at 2 cm from the source shield. The instrument stand, specially built to minimize radiation scatter, is fully adjustable and supports a television camera for remote observation. (auth)

31490 USSR ACTIVITIES IN THE SECTOR OF RADIOISOTOPES. Com. Naz. Energ. Nucl., Notiz., 15: 78-80(May 1969). (In Italian).

Considerable work on the applications of radiation sources in the USSR is reviewed. Among other things, an industrial radiochemical plant equipped with a ^{60}Co source and a ^{137}Cs mobile irradiation facility for commercial purposes were built. (auth)

31491 MEASUREMENT OF THE ABRASION USING RADIOISOTOPES. MEASUREMENT FOR THE ROTOR OF A VACUUM PUMP. Nojiri, Toshiaki (Industrial Research Inst., Yokohama, Japan); Masilungan, Benedicto A. Kanagawa-ken Kogyo Shikenjo Kenkyu Hokoku, No. 22, 51-4(Sept. 1968). (In Japanese).

For abrasion measurements of the rotor of a vacuum pump, the rotor was irradiated in a nuclear reactor. The measurements were made by the radioisotope technique and other methods. In both the β-particle and the γ-ray measurements, the latter was found to be most effective. For γ-ray measurements, lubricating oil was withdrawn, and a scintillator was inserted in the oil to measure the γ-rays. For the β measurement, which was continuous, no increase in the count rate was observed. In this case the specific activity must be increased. (NSA of Japan)

31492 GENERATION AND CONTAINERIZATION OF RADIOISOTOPES. Ogier, George; Schumate, Donald J. (to Mallinckrodt Chemical Works). U. S. Patent 3,446,965. May 27, 1969. Filed Aug. 10, 1966.

Apparatus and method for generating a sterile daughter radioisotope solution from a generator charged with a parent radioisotope and containerizing the daughter radioisotope in an evacuated container are described. The apparatus includes a shield having an upper chamber for receiving the generator and a lower compartment for receiving an evacuated container and a containerization unit. The shield is provided with a door for insertion and removal of the container and containerization unit. The containerization unit contains a transfer vessel for receiving the eluate containing the dissolved radioisotope. The vessel has a tubular needle adapted to pierce a stopper in the evacuated container for suction of the eluate from the vessel into the evacuated container. The vessel is supported in the lower compartment above the container. The vessel and container are adapted for relative vertical movement to cause the needle to pierce the stopper. (Offic. Gaz.)

Materials Testing

Refer also to abstracts 31481 and 31576.

31493 (MLM-1617) EVALUATION OF NEUTRON RADIOGRAPHY FOR RADIOISOTOPIC HEAT SOURCES. Barnett, A. G.; Bauer, A. R.; Gray, M. I. (Mound Lab., Miamisburg, Ohio). June 5, 1969. Contract AT-33-1-GEN-53. 20p. Dep. CFSTI.

Neutron radiography was evaluated for application on isotopic heat sources. Three specimens were radiographed: a Haynes alloy No. 25 container filled with a 50-50 wt % mixture of tungsten and molybdenum; a tantalum-10 wt % tungsten cylinder with a welded end cap, and a radioactive heat source containing three small capsules of ^{238}Pu metal. Neutron radiographs were compared with gamma and x-ray radiographs and were found to compete favorably in most cases. (auth)

31494 (ORNL-TM-2524) AN X-RAY TECHNIQUE FOR MEASURING THICKNESS OF TUNGSTEN ON COPPER. Foster, B. E.; Snyder, S. D. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 11p. Dep. CFSTI.

An x-ray attenuation technique to measure the thickness of vapor-deposited tungsten on the inside wall of copper tubing was developed. The radiation source was a Norelco MG-150 x-ray unit operated at 150 kVcp and 3 ma with copper filtration to reduce the overall beam intensity and absorb the low-energy x rays. Narrow beam collimation was used and directed the beam radially into the duplex tube. The detector, placed in the bore of the tube, consisted of a NaI(Tl) crystal optically coupled to a commercial fibre optics bundle. The bundle was optically coupled to a photomultiplier tube. The output signal from the photomultiplier was monitored by a digital voltmeter. The detector was held stationary in the beam and positioned for maximum signal. The tube to be measured was translated with the detector remaining on the axial center of the tube. Measurements were made at specified circumferential and longitudinal positions. Our calibration curve was obtained by plotting the voltmeter reading versus the thickness of rolled tungsten sheet specimens. As the x rays passed through the duplex wall, the tungsten attenuation had the greatest effect per unit of thickness, thus minimizing the effect of any variations in copper wall thickness. A copper thickness change of 0.005 in. was equivalent to a 0.0005-in. tungsten thickness and produced that tolerance on the final thickness determinations. (auth)

31495 (ORNL-TM-2525) X-RAY ATTENUATION SCANNING OF NUCLEAR FUEL PLATES. Foster, B. E.; Snyder, S. D.; Knight, R. W. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 13p. Dep. CFSTI.

A sophisticated technique has been developed and successfully used for high-speed homogeneity evaluation of reactor fuel plates. Specially designed x-ray equipment is used as the irradiation source, while a NaI(Tl) crystal optically coupled to a photomultiplier tube serves as the radiation detector. Careful control of the operating conditions produces very accurate and reproducible results. The method uses the x-ray attenuation principle, and on recent applications the area of evaluation has been as small as 0.0048 $in.^2$. Precise mechanical x-y scanning of the fuel plate is accomplished with longitudinal speeds of 0 to 250 in./min and horizontal indices of 0 to 5 in. in 0.001 in. increments. The system is provided with recording capabilities for continuous quantitative data or automatic readout for a go no-go operation. Tolerance limits are set by a series of programmed equivalent attenuation standards at the beginning of each longitudinal pass of the fuel plate through the x-ray beam. The advantages and capabilities of the system are discussed relative to its use in industry. (auth)

31496 NONDESTRUCTIVE TESTING. Sharpe, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Atom, No. 152, 155-74(June 1969).

The range of techniques available for nondestructive testing (N.D.T.) is indicated and areas in which there is active development are highlighted. Areas in need of further development are also discussed. A description is included of the N.D.T. Center at Harwell, and the nature and significance of some of its development programs are discussed. (UK)

31497 NEUTRON RADIOGRAPHIC EXAMINATION OF VAPOR BUBBLE FORMATION AS A LIMITATION ON PLANAR HEAT PIPE PERFORMANCE. Moss, Richard Alan. Princeton, N. J.; Princeton Univ., 1968. 145p.

Thesis.

An experimental study of the limiting heat transfer conditions in a planar heat pipe using water as a working fluid was conducted. The apparatus was designed to study the boiling processes that occur in the wick structure of a heat pipe. The vapor blanket which formed in the porous medium, i.e., the wick, during heat transfer was experimentally examined using neutron radiography. The neu-

tron source for these experiments was the Industrial Reactor Laboratories' 5 megawatt reactor. The neutron radiographic system was composed of the following basic elements: a beam tube, the object (a planar heat pipe), a neutron image intensifier tube, and image recording cameras. Using the image intensifier, it was possible to quantitatively measure the thickness of water present to ±.006 inches for thicknesses up to .125 inches. The imaging system has a lateral resolution of .0135 inches. Two heat transfer models were postulated and analytically formulated. One model assumed that evaporation occurred only from the upper surface of the wick, the second assumed that vapor was generated at the base of the wick and released solely from the sides of the wick. The data taken under conditions of varying heat transfer rate and angles of wick inclination demonstrated that, with a secondary assumption of variable pore size, the second model was more realistic than the first. The basis for the assumption of variable pore size is suspected to be a result of the "Leverett effect." The effects of wick cleaning, contact angle, and pore size distribution are also discussed. (Disser. Abstr.)

31498 A METHOD FOR THE NONDESTRUCTIVE TESTING BY EDDY CURRENTS OF ELECTRICITY CONDUCTING TUBES. Dufayet, Jean-Pierre (to Commissariat a l'Energie Atomique). British Patent 1,154,300. June 4, 1969. Priority date May 25, 1967, France.

Eddy current equipment is described for nondestructively testing electric conducting tubes for well localized faults, such as cracks or inclusions. The tube to be tested is placed inside the windings of two coupled Hartley oscillators that are practically identical. The windings are separated by a distance short enough to allow the oscillators to generate sine waves at the same frequency whatever the characteristics of the tube may be. The difference between the potentials of the Vg 1 and Vg 2 grids of the triodes of the Hartley oscillators is measured. A fault in the tube located in the first winding reduces Vg 1 and increases Vg 2. (F.S.)

31499 NONDESTRUCTIVE TESTING OF NUCLEAR REACTOR FUEL ELEMENTS. Thompson, W. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Brit. J. Non-Destruct. Test., 11: 12-18(Mar. 1969).

The techniques used at Springfields for the nondestructive testing of fuel elements of various types and their components are briefly described, including eddy current testing of Magnox cans, measurement of wall thickness of uranium tubes, ultrasonic testing of thin walled stainless steel tubing, measurement of nickel plating thickness, use of the γ-absorptiometer for inter-pellet gap detection, and examination of Magnox fuel element welds using an x-ray sensitive Vidicon camera. (UK)

31500 EDDY CURRENT TESTING OF FAST REACTOR FUEL SUBASSEMBLY CLADS. Dufayet, Jean-Pierre (Centre d'Etudes Nucleaires, Cadarache, France). Mater. Eval., 27: 129-34(June 1969).

Nondestructive testing of small-diameter (around 7 mm, i.e., 0.28 in.), thin (0.3 to 0.5 mm, i.e., 0.01 in.), 1 meter long austenitic stainless steel tubes was performed. The goal is a systematic investigation not only of defects, such as cracks or metal tearing occurring in the processing phase, but also of any heterogeneity within the material. Tests were carried out over relatively large samples of tubes of various origins obtained through different process techniques. The tubes are tested successively with two pieces of eddy current equipment: a Model 2180 Förster Defectograph and an experimental laboratory piece. Large displacement speeds permit each tube to be tested many times with each kind of equipment. The obtained results using four frequencies in the 10 to 700 kHz range are compared with many impedance data of the exploring coils. A wide pattern of defects has already been identified, the nature of which was later confirmed by micrographic examinations. As an application of these results, an automatic testing unit equipped with a fast data-processing system is described briefly. (auth)

31501 USING NUCLEAR EXPERIENCE TO SET UP A NATIONAL CENTER FOR NONDESTRUCTIVE TESTING RESEARCH. Sharpe, R. S. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Bull. Inform. Sci. Tech. (Paris), No. 135, 15-20 (Mar. 1969). (In French).

The successful realization of nuclear power production in Great Britain has led to a reduction of the amount of work in the nuclear research and development laboratories and allows them to engage in non-nuclear activities. The experience gained in the nuclear field has served as an advantage in developing research and development activities for nondestructive testing. (auth)

31502 NONDESTRUCTIVE TESTING IN THE LOS ALAMOS SCIENTIFIC LABORATORY. Tenney, G. H.; Edenborough, N. B.; Fullbright, H. J.; Gregory, T. G. Bull. Inform. Sci. Tech. (Paris), No. 135, 21-8(Mar. 1969). (In French).

Laboratory activities discussed on nondestructive testing are: eddy-current detection of cracks in atomic reactor components under high thermal transient conditions; on-line application of small, programmable electronic computers to the analysis and reduction of nondestructive testing data; and total replication of the bore surface of a tube, using a polyvinyl chloride tubing inserted in the bore, heated to 150°C, and inflated by internal pressure. (auth)

31503 ULTRASONIC METHOD OF TESTING THIN TUBES, ALLOWING A SEPARATED RECORDING OF EXTERNAL DEFECTS AND INTERNAL DEFECTS. Chretien, J. F.; Huard, J. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 135, 35-42(Mar. 1969). (In French).

Ultrasonic testing of tubes intended for fuel element cladding is discussed. Defect locations in the outer and inner walls of the tube are determined. The method is based on differences in the damping of the Lamb waves at the air-metal and metal-water interfaces allowing separate recordings to distinguish between internal and external defects. (auth)

31504 PROPERTIES OF ULTRASONIC CONTROL SYSTEMS, THEIR DEFINITION AND MEASUREMENT. Krautkramer, J. (Gesellschaft fuer Elektrophysik, Cologne). Bull. Inform. Sci. Tech. (Paris), No. 135, 43-8(Mar. 1969). (In French).

In the nondestructive testing of nuclear reactor construction parts, the reliability of the ultrasonic equipment is of great importance. Characteristics of the electronic apparatus and the properties of the ultrasonic field of the probes define the most important characteristics to explain the measurement methods. (auth)

Protective Structures

31505 (AD-681697) ANALYSIS OF SOME EXPERIMENTS ON FALLOUT SHIELDING BY ABOVE-GROUND STRUCTURES. Ferguson, James M. (Naval Radiological Defense Lab., San Francisco, Calif.). June 17, 1968. 55p. (USNRDL-TR-68-95). CFSTI.

The current method for predicting the protection against fallout radiation by above-ground structures was tested against various experiments. The scope of the study was limited to the radiation entering the structure by penetrating vertical barriers. Various approximations inherent in the method, such as energy dependence, assumed barrier shapes, and separation of barrier and geometry effects, were investigated by comparison with experiments. It is found that the existing method gives reasonable agreement for the types of structures of interest in applications of the method. Estimates of the resulting errors are given. (auth) (USGRDR)

31506 (AD-843583) NUCLEAR RADIATION SHIELDING IN THE DESIGN OF HARDENED STRUCTURES. Huddleston, C. M.; Doty, D. R.; Ingold, W. C. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Oct. 1968. 24p. (NCEL-TR-599). CFSTI.

The transmitted dose of initial radiation is related to peak overpressure, weapon yield, and shield thickness. It is shown that the minimum expected weapon size determines the thickness of radiation shield for a specific overpressure. A simplified method is presented for determining the protection factor for two-legged ducts. The designer can use either graphical methods or a nomogram. A mathematical analysis is included that relates protection factors to percent lethalities due to fallout radiation. (auth) (USGRDR)

Radioactive Material Handling

Refer also to abstract 31415.

31507 (BNWL-1004) ESTIMATION OF MOLTEN CORE SIZE IN WASTE STORAGE VESSELS AND FROZEN WALL WASTE MELTERS. Kaser, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 8p. Dep. CFSTI.

Equations for calculating the size of molten cores in cylindrical and spherical vessels containing highly radioactive heat-generating waste are derived. These equations may be used for cases where (1) all heat is generated by radioactive decay, and (2) internal heaters supply heat in addition to the radioactive decay heat. (auth)

31508 (CEA-CONF-1255) WORK WITH RADIOACTIVE MATERIAL IN GLOVE BOXES ON THE INDUSTRIAL SCALE. Lalu, Pierre (Commissariat a l'Energie Atomique, [Grenoble] (France). Centre d'Etudes Nucleaires). Aug. 1967. 26p. (In French). (CONF-680952-1). Dep.

From 10th National Conference on Industrial Medicine, Grenoble, France.

The construction of glove boxes, including the recycling system, the gloves, and the environment control, is described. The work done in glove boxes is illustrated by a description of a milling procedure. The medical profile of personnel allowed to work with glove boxes is outlined. (J.S.R.)

31509 (CEA-R-3721) REVIEW OF THE INCINERATION OF 500 TONNES OF RADIO-ACTIVE RESIDUES. Rodier, Jean; Seyfried, Philippe; Charbonneaux, Michel (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Apr. 1969. 14p. (In French). Dep.

During its first five years operation, the incinerator at the Marcoule Center has burned almost 500 tons of radioactive residues. Improvements in some of the details of the process have been made during this period; they concern the nature of the materials involved. The technical and radiological results for the installation are very favorable, and have made it possible to maintain a high charge factor. Although the overall economic results are not advantageous in the case of ungraded solid residues this method is the best available for eliminating oils, solvents, wood and dead animals. It can also be of use each time that a dilution in the atmosphere can advantageously be used as a method of disposing of certain radioelements such as tritium or carbon-14 in the form of gases or vapors. (auth)

31510 RADIOACTIVE WASTE DISPOSAL. Fry, Richard M. (Kentucky Dept. of Health, Frankfort). Amer. J. Public Health, 59: 448-50(Mar. 1969).

Operational experience is reported which has shown that large quantities of solid radioactive material can be disposed of safely by carefully controlled land burial. This conclusion was reached on the basis of a program conducted in Kentucky since 1963. To date, about 900,000 ft^3 and over 300,000 Ci of radioactive material have been buried at Maxey Flats, Kentucky. The current rate of burial is in excess of 200,000 ft^3/yr and ~4000 Ci is buried each month. The material being buried is restricted to packaged solid waste of low hazard potential. Originally only very low concentration wastes were disposed of at this site, but subsequently the operations changed to include such items as decayed radioactive teletherapy sources, reactor thermocouples, and end boxes, which are highly radioactive but present a very low potential for the leaching of the radioactive material involved. The 3 types of burial operations are described. In addition to large trenches, dry wells are constructed out of concrete and steel pipe with concrete footings. These hot wells are used for the disposal of highly radioactive sources, by covering each successive layer with concrete to immobilize them and to reduce the radiation intensity at the surface. A third type of burial operation is used for liquid waste, which is processed in a concrete mixer with the addition of clay and cement. This semisolid slurry is then poured into a plastic-lined trench where it solidifies and is subsequently covered with compacted clay. Safety precautions are also described. (BBB)

31511 TRANSPORTATION REGULATIONS FOR RADIOACTIVE MATERIALS. Colsmann, Paul (Brookhaven National Lab., Upton, N. Y.). Nucl. Safety, 10: 328-36(July-Aug. 1969).

The primary purpose for the regulations concerning the transport of radioactive materials is to control the potential hazards to the carriers and the general public. An evaluation of a shipment in terms of the regulatory requirements and limitations necessitates a knowledge of such factors as quantity and type of radioactivity, radiation levels, and possibly criticality. It is doubtful that the average traffic manager handling such shipments has the necessary background to perform this evaluation. Guidance is generally provided by a health physicist and, from this point of view, that health physicist should have a working knowledge of the regulatory requirements and limitations and should have access to the most recent revisions. (auth)

31512 DISPOSAL OF RADIOACTIVE WASTES BY HYDRAULIC FRACTURING. PART V. SITE EVALUATIONS. McClain, W. C. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 9: 315-26(Mar. 1969).

Although hydraulic fracturing has been shown to be a safe and economical method of waste disposal at the Oak Ridge National Laboratory, it will be necessary to carry out an extensive site examination program before the technique can be used at any other location. The most difficult part of this site examination is proving that the hydraulically induced fractures in the underground rocks are horizontal or nearly so. A site-testing program which utilizes several methods of remote determination of fracture orientation is discussed, but confirmatory core holes from the surface intersecting the test grout sheets will be required. (auth)

Vacuum Engineering

31513 MATERIALS OF HIGH VACUUM TECHNOLOGY. VOLUME 3. AUXILIARY MATERIALS. Espe, Werner. New York, Pergamon Press, 1968. 548p. $40.00.

Translation of Werkstoffkunde der Hochvakuumtehnik.

Materials used in high vacuum technology are discussed. Information on luminescent materials (phosphors), elastomers (rubber and related materials), sealants (oils, greases, waxes, and cements), lubricants, organic pumping fluids and manometer oils, base and cap cements for tubes and lamps, gases, and vapors is presented. An extensive bibliography is included. (J.C.W.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 31489, 31738, and 32889.

31514 (AD-679676) NEUTRON FLUENCE AND DOSE MEASUREMENTS WITH FISSION FOIL-LEXAN DETECTORS. Rago, Paul F.; Goldstein, Norman; Tochilin, Eugene (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 4, 1968. 30p. (USNRDL-TR-68-126). CFSTI.

A fission foil-Lexan detector system has been developed to monitor reactor neutrons. It is similar to the system based on counting fission gamma rays but has some advantages; i.e., permanently recorded tracks that can be read any time after exposure; integrated recording; microgram amounts of fissionable material needed; independence of fission product distribution; and the elimination of specialized gamma-ray counting equipment. Fission product damage tracks in the Lexan (or mica) are counted under an optical microscope. Fluence is determined from the sensitivity factor of 0.0000116 tracks/neutron-barn. Experimental results are given. (auth) (USGRDR)

31515 (AD-682922) CHARGED PARTICLE TRACKS IN POLYMERS NO. 7: SENSITIVITY ENHANCEMENT OF LEXAN. Benton, Eugene V.; Henke, Richard P. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 22, 1968. 12p. (USNRDL-TR-68-136). CFSTI.

Ultraviolet radiation in the presence of oxygen has been used to greatly enhance track-etching rates in Lexan polycarbonate nuclear particle track detector. When irradiated detectors are stored in darkness, the slow variation of chemical track reactivity with the age of latent tracks can be explained as being caused by the presence of oxygen. (auth) (USGRDR)

31516 (NP-17917) FISSION TRACK SOLID STATE DETECTOR. Bib. 232. Burjan, V. (Ceskoslovenska Akademie Ved, Prague. Ustav Jaderneho Vyzkumu). Oct. 22, 1968. 9p. (In Czech). Dep.

A list of 46 reports and publications, compiled from NSA volumes 17-22 is presented. (W.H.K.)

31517 (NYO-3870-2) HIGH-PURITY GERMANIUM FOR GAMMA DETECTORS. Annual Report No. 2, May 1968-April 1969. Hall, R. N.; Baertsch, R. D.; Soltys, T. J. (General Electric Co., Schenectady, N. Y. Research and Development Center). May 1969. Contract AT(30-1)-3870. 4p. Dep. CFSTI.

Progress in the purification of germanium and the fabrication of p-i-n junctions for gamma detection is summarized. (W.H.K.)

31518 (RD/B/N-1336) MAINS-OPERATED CADMIUM SULPHIDE DETECTOR HIGH-LEVEL GAMMA EXPOSURE RATE-METER. Hudd, W. H. R.; Walker, W. N. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Apr. 1969. 9p. Dep.

A mains operated cadmium sulphide crystal detector high level gamma exposure-rate meter covering the range 1 R/hr to 50 KR/hr is described. A radiation level at which a trip is required to operate may be pre-set. When this level is reached indication is provided on the instrument and a mains output is available to drive external equipment. (auth)

31519 (UCRL-50007-68-3, pp 34-8) RADON DAUGHTER EQUILIBRIUM MEASUREMENTS IN URANIUM-MINE ATMOSPHERES. Lindeken, C. L. (California Univ., Livermore. Lawrence Radiation Lab.).

When radon gas formed from radioactive decay of uranium escapes from exposed ore surfaces and enters the mine atmosphere, a series of short-lived daughter products is formed and becomes a potential hazard to mine workers. In an unventilated mine or in a section of the mine that is poorly ventilated, these daughter products will accumulate and will approach equilibrium with radon. Various methods for measuring radon daughter equilibrium are discussed. A prototype plutonium alpha air monitor using a 450 mm^2 surface-barrier silicon diode is described for determining this radon daughter equilibrium. (B.G.D.)

31520 (UCRL-50007-68-3, pp 46-50) CONSTRUCTION OF AN UNDERGROUND WHOLE-BODY-COUNTER SHIELD. Griffith, R. V.; Anderson, A. L. (California Univ., Livermore. Lawrence Radiation Lab.).

A new type of low-background whole-body-counter shield has been built underground using serpentine which has a very low radioactive content as shield material. (auth)

31521 IMPROVEMENTS IN $4\pi\beta-\gamma$ COINCIDENCE COUNTING. De Roost, E.; Funck, E.; Spernol, A. (EURATOM, Geel, Belgium). Int. J. Appl. Radiat. Isotop., 20: 387-91(May 1969).

The construction of proportional counters is discussed in connection with problems of afterpulses. The influence of discrimination is also considered. (auth) (UK)

31522 CALIBRATION OF A GM DETECTOR TO MEASURE ^{15}O AND ^{13}N IN AIR BY IMMERSION IN A STANDARDIZED ^{32}P SOLUTION. Holeman, G. R. (Yale Univ., New Haven). Health Phys., 17: 158-60(July 1969).

The purpose of this study was to select a beta emitter that could be used in solution to calibrate a GM survey meter to indicate the air concentration of ^{15}O and ^{13}N in a LINAC facility. The solution was 0.1 $\underline{N}$ H_3PO_4. (auth) (UK)

31523 CONSTRUCTION OF A GEIGER-MUELLER COUNTER WITH A REPLACEABLE WINDOW. Rous, J.; Skowronek, M.; Cabannes, F. Rev. Phys. Appl., 4: 21-3(Mar. 1969). (In French).

Soft x ray detection in a preionized gaseous channel explosion in atmospheric air was studied. To offset the destructive effects of discharge shock wave, a Geiger-Mueller counter was converted into a counter with a replaceable window; the detection lower limit of the counter has thus been brought down to 5.5 keV. (auth)

31524 DETECTION OF CAVITIES PRODUCED IN A LIQUID BY IONIZING PARTICLES. Marietti, P.; Sette, D.; Wanderlingh, F. (Univ., Rome). J. Acoust. Soc. Amer., 45: 515-18(Feb. 1969).

As a possible means for detection and dosimetry of fast neutrons, a new technique for the detection of cavitation nuclei in liquids was developed. Microbubbles created by high-energy ionizing particles give rise to an additional absorption of sound, at frequencies determined by their size. From the experimental measurement of the acoustic absorption coefficient as a function of the frequency, the presence of bubbles of various sizes can therefore be detected. Microbubbles created in water by fission fragments of ^{238}U were detected. A reverberation method was used, allowing a continuous variation of frequency in the range 100 to 900 kcps. The signal was treated by means of a sampling technique that provided a fast response with sufficient accuracy. The size distribution of microbubbles produced in the ^{238}U solution appeared closely related to the well-known energy distribution of fission fragments. A comparison was made of the ratio between absorption coefficients in irradiated and nonirradiated solutions. The rate of spontaneous fission of ^{238}U was taken as 25 g^{-1} hr^{-1}. This gave about 0.2 event/sec. For neutron-induced fission a cross-section of 1 b and a neutron flux of about 0.5×10^4 sec^{-1} were taken which give a number of events of sec^{-1}, about 25 times larger than in the case of spontaneous fission. This figure agreed with experimental results if a comparison was made of the areas bounded by the respective absorption curves. (BBB)

31525 TECHNIQUE FOR PREPARING AND MOUNTING THIN NICKEL FOILS. Carr, D. L. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Rev. Sci. Instrum., 40: 965-6 (July 1969).

A method for mounting thin self-supporting nickel foils onto aperture plates to be used for setting the energy thresholds of low energy particle detectors for satellite measurements on auroras is described. (auth)

31526 SCINTILLATOR LIQUID. Krasovitskii, Boris Mordukhovich; Poduzhailo, Vladimir Fedorovich; Podgornaya, Liya Mikhailovna; Globus, Rafail Lvovich. U. S. Patent 3,444,094. May 13, 1969. Filed June 14, 1966.

New liquid scintillators which have high scintillation efficiency and high boiling point and are non-flammable are described. The new scintillators consist essentially of oxazoles and/or 1,3,4-oxadiazoles in purified ditolylmethane. (Offic. Gaz.)

31527 RADIOACTIVE RADIATION COUNTER TUBE WITH IMPROVED HIGH TEMPERATURE PROPERTIES. Perelman, Simon Meerovich; Prager, Isaak Aronovich; Tolmachev, Anatoly Filippovich; Klebanov, David Lvovich; Gastev, Jury Alexandrovich. U. S. Patent 3,444,376. May 13, 1969. Filed June 1, 1965.

Radiation counter tube including elements with a work function of 3.5 electron-volts at operating temperature and separators having a TK-100 minimum of 475°C and an envelope of 54% SiO_2, 18.5 Al_2O_3, 13.5% CaO, 4% BaO, and 6% ZnO is discussed. (Offic. Gaz.)

31528 MEASUREMENT OF THE QUANTITY OF COLLECTED CHARGE IN SEMICONDUCTOR DETECTORS. Zakharchuk, O. V. Prib. Tekh. Eksp., No. 1, 102-4(Jan.-Feb. 1969). (In Russian).

An analysis was conducted on the passage of pulse from detectors through spectrometer circuits, which consist of a charge-sensitive preamplifier and pulse shaper. The correction factor was calculated in order that the collected charge could be measured when the duration of the pulse from the detector does not coincide with the duration of the pulse from a generator. A plan was given which permits obtaining stable pulses and the measurement of their amplitude with high accuracy. (tr-auth)

31529 CONCERNING THE AMPLITUDE RESOLUTION OF PHOTOMULTIPLIERS. Melamid, A. E.; Potalov, A. M. Prib. Tekh. Eksp., No. 1, 143-5(Jan.-Feb. 1969). (In Russian).

A method is described for measurement of the amplitude resolution of photomultiplier tubes, based on the use of a light flash with a known quantity of photons and spectrum characteristics identical to that produced in NaI(Tl) scintillators. Such flashes can work not only for the determination of the amplitude resolution of photomultiplier tubes, but for the determination of the efficiency of scintillation crystals. (tr-auth)

31530 X-RAY SCINTILLATION DETECTOR FOR THE RADIATION OF LIGHT ELEMENTS. Alperovich, V. R.; Komyak, N. I.; Khai, D. M. (Design and Construction Bureau for X-Ray Apparatus, Leningrad). Prib. Tekh. Eksp., No. 1, 46-9(Jan.-Feb. 1969). (In Russian).

A scintillation detector is described for the detection of x-rays at energies up to 1.5 keV with an efficiency of 80% for radiation from Cu-K_α, S-K_α, and 60% for radiation from Si-K_α and Al-K_α. (tr-auth)

31531 PLASTIC BORON-CONTAINING SCINTILLATORS. Anisimova, G. I.; Danelyan, L. S.; Zhigach, A. F.; Lazarenko, V. R.; Siryatskaya, V. N.; Sorokin, P. Z. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp., No. 1, 49-51(Jan.-Feb. 1969). (In Russian).

The luminescence properties, self-absorption characteristics, and neutron sensitivity of boron-containing plastic scintillators with a base of polystyrene were investigated. The introduction of boron in the scintillator of up to 5% does not have any significant effect on transparency. The intensity of scintillations from the interaction of alpha particles from the reaction $^{10}B + n \rightarrow {}^{7}Li + \alpha$ corresponds to the intensity of scintillations from electrons with energies of approximately 100 keV. The Fwhm of the alpha spectrum is equal to 50% and the relation of luminescence from recording alpha particles and the electrons of equal energy shows that $\alpha/\beta = 0.07$. (tr-auth)

31532 THERMOSTABLE PLASTIC FILM SCINTILLATORS BASED ON ISOTACTIC POLYSTYRENE. Chernobai, A. V.; Shepeleva, A. I.; Grudskaya, L. E. (Scientific Research Inst. of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 1, 52(Jan.-Feb. 1969). (In Russian).

A method was developed for obtaining plastic film scintillators based on isotactic polystyrene which possesses a higher light yield and thermal stability than amorphous polystyrene. The change in the pulse amplitude from the scintillator in the temperature range 20-180°C did not exceed ±10%. (tr-auth)

31533 AN ALPHA-GAMMA COINCIDENCE SPECTROMETER WITH GAS-DISCHARGE COUNTER AND SILICON DETECTOR. Grigorev, O. I.; Shimanskaya, N. S. Prib. Tekh. Eksp., No. 1, 53-5(Jan.-Feb. 1969). (In Russian).

A spectrometer was described for recording of coincidences with gas-discharge counters and silicon detectors. The spectrometer can be used for the measurement of absolute yields of soft (<100 keV) gamma rays by studying the decay schemes of alpha-radioactive isotopes, for determining yields of x-rays from heavy elements, and for analysis of mixtures of alpha-radioactive isotopes. (tr-auth)

31534 CONCERNING THE ERRORS DURING WORK WITH PULSE SOURCES OF RADIATION AND COUNTERS WITH EXTENDED DEAD TIME. Cherkasov, A. S.; Borzhkovskii, V. F.; Chkalov, I. I.; Mashkarov, Yu. G. (Kharkov State Univ.). Prib. Tekh. Eksp., No. 1, 62-4(Jan.-Feb. 1969). (In Russian).

The problem concerning the errors during work with pulse sources of radiation and with counters with extended dead time, when the resolving time of the counter is less than or equal to the pulse duration of the radiation was examined. It was assumed that the number of particles entering the counter for an arbitrary segment of time is distributed according to a Poisson distribution and the pulse of radiation have a rectangular form. The results obtained, in the form of diagrams and tables, can be used for the evaluation of errors of measurements and for designing counting equipment. (tr-auth)

31535 AMPLIFIER-LIMITER FOR FAST COINCIDENCE CIRCUITS. Sit'ko, S. P.; Shevchenko, V. A. (Kiev State Univ.). Prib. Tekh. Eksp., No. 1, 65-6(Jan.-Feb. 1969). (In Russian).

An amplifier-limiter for pulse shaping in fast coincidence circuits used with CsI(Tl) and NaI(Tl) scintillators is described. The apparatus provides, for the range of input signals of amplitude 3-120 v and pulse duration 0.3 μsec, a standard signal of constant amplitude ~12 v and constant pulse duration (less than 15 nsec). (tr-auth)

31536 AUTOMATIC SUBTRACTION OF BACKGROUND. Podol'nyi, E. I.; Selyaninov, Yu. E. (Belorussian State Univ., Minsk). Prib. Tekh. Eksp., No. 1, 67-9(Jan.-Feb. 1969). (In Russian).

An apparatus was described, which when operated in a complex system with conversion characteristics, has a time-determining plan of control. Primarily the operation of the apparatus was based on the utilization of binary reversible scalers with controlled reverse. The apparatus is included between the input circuits and the recording system. The background is subtracted during the experiment and only useful information is introduced into the recording system. (tr-auth)

31537 MULTIPURPOSE PULSE SHAPING IN COINCIDENCE TECHNIQUES IN THE NANOSECOND RANGE. Sanin, A. A.; Shareiko, P. N. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 1, 74-9(Jan.-Feb. 1969). (In Russian).

The problems of multipurpose pulse shaping were examined. A scheme with a driven multivibrator with a tunnel diode and a transistor with delayed feedback coupling was described. The delay time depends on the quantity of time-determining capacity of the feedback coupling circuit and can be changed continuously in a wide range. Standardization and branching schemes are proposed, which form pulses of 4 to 6 nsec duration and 1.2 to 1.6 nsec rise-time. A test involving scintillation detectors with coincidence schemes obtained resolving times of 2.3 to 2.8 nsec. The temperature coefficient was 0.06%/°C. The application of the driven multivibrator as a pulse amplitude discriminator in coincidence schemes was also discussed. (tr-auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 32902, 33087, and 33088.

31538 (BNL-13683) SIGNAL FILTERING-HIGH COUNTING RATE PROBLEMS. Radeka, V. (Brookhaven National Lab., Upton, N. Y.). [1968]. 26p. (CONF-680906-21). Dep. CFSTI.

From International Symposium on Nuclear Electronics, Versailles, France.

Comments on optimum signal processing for pulse-amplitude spectrometry at high rates are presented. Discussed are signal processing and the weighting function; signal detection, timing, and amplitude measurements; pileup rejection; and realization of weighting functions and systems considerations including both time-invariant and time-variant filters. (W.H.K.)

31539 (CLOR-72) DISTORTION TO SPECTRA AND THE EFFICIENCY OF SILICON DETECTORS FOR DIFFUSIVE INCIDENCE TO THE DETECTOR OF ELECTRONS FROM ^{14}C AND ^{35}S SOURCES. Slapa, M.; Dabrowski, A.; Glowacki, S.; Jarosiewicz, I.; Roman, J. (Centraline Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1968. 20p. Dep.

The distortion to beta spectra, measured by means of silicon detectors in 2π and 4π geometry was studied for carbon-14 and sulfur-35 sources. A method of measurement of absolute efficiency of 2π counter is described, and the efficiency dependence on the discrimination level is established. (auth)

31540 (UCRL-50007-68-3, pp 21-5) MEASUREMENT OF THE NEUTRON SPECTRUM FROM THE LPTR FAST NEUTRON IRRADIATION FACILITY. Griffith, R. V. (California Univ., Livermore. Lawrence Radiation Lab.).

The measurement of the flux and integral spectrum of the fast neutron irradiation facility at the LPTR using a combination activation and fission foils is described. (auth)

31541 RISE-TIME DISCRIMINATOR FOR PROPORTIONAL COUNTERS. Besenmatter, W.; Drosg, M.; Weinzierl, P. (Technische Hochschule, Vienna). Acta Phys. Austr., 28: 46-58(1968). (In German).

Circuits of a rise-time discriminator to be used for background reduction in low-energy γ-spectroscopy with proportional counters are presented. With the Moessbauer effect which allows one to distinguish "line"-pulses from "background"-pulses the performance of the discriminator was studied with respect to different types of proportional counters. (auth)

31542 PROPERTIES OF A DOUBLE-FOCUSING SECTOR-TYPE β SPECTROMETER. PART I. Caeymaex, S.; Boving, R.;

Jones, A.; Martegani, A. (Univ., Louvain, Belgium). Rev. Phys. Appl., 4: 1-5(Mar. 1969). (In French).

The performance of a double-focusing sector-type β-spectrometer is calculated. The spectrometer is composed of two sectors, one with homogeneous field and another with inhomogeneous field. The purpose is to use this apparatus on line with an accelerator. (auth)

31543 CONSTRUCTION OF A DOUBLE-FOCUSING SECTOR-TYPE SPECTROMETER. PART II. Boving, R.; Caeymaex, S.; Jones, A.; Martegani, A. (Univ., Louvain, Belgium). Rev. Phys. Appl., 4: 6-12(Mar. 1969). (In French).

Construction of a two sector type spectrometer with one homogeneous field and one inhomogeneous field is described. Conversion electrons of ^{137}Cs, ^{198}Au, and ^{192}Ir sources have been measured. Source dimensions are 0.5 cm × 3 cm, the solid angle is $3 \times 10^{-3}\ \Omega/4\pi$, and the resolving power is 4.5×10^{-4}. (auth)

31544 APPARATUS FOR RECORDING THE ABSORPTION OF GAMMA RAYS EMANATED FROM A SOURCE. Kankeleit, Egbert (to California Inst. Research Foundation). U. S. Patent 3,446,962. May 27, 1969. Filed Sept. 30, 1966.

A Moessbauer spectrometer is provided wherein a gamma ray source emits gamma rays at a target which is continuously moved relative to the source with a changing velocity. Film holding means are provided which is moved in synchronism with the moving target to repeatedly bring particular portions of film directly in position for exposure only when the relative velocity of the source and the target is of a particular value. (Offic. Gaz.)

31545 THE MEASUREMENT OF THE RESOLUTION OF NEUTRON SPECTROMETERS. Muradyan, G. V.; Adamchuk, Yu. V.; Shchepkin, Yu. G. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp., No. 1, 28-30(Jan.-Feb. 1969). (In Russian).

A method is proposed for experimental determination of the resolution function of neutron spectrometers used for the measurement of neutron cross sections at resonance. (tr-auth)

31546 CHERENKOV SPECTROMETER FOR HIGH-ENERGY PHOTONS AND ELECTRONS. Bekrenev, V. S.; Kruglov, S. P.; Shchetkovskii, A. I. (Physico-Mechanical Inst., Leningrad). Prib. Tekh. Eksp., No. 1, 25-8(Jan.-Feb. 1969). (In Russian).

A total-absorption Cherenkov spectrometer for recording photons and electrons with energies $E \geq 100$ MeV is described. The radiator consists of two rectangular blocks of lead glass attached to four photomultipliers. In the energy range 0.1–0.5 GeV the resolution at Fwhm is changed from 38 to 15%. (tr-auth)

High Energy Physics Instrumentation

31547 (AD-417141) OPERATION OF BUBBLE CHAMBER WITH LIQUID NITROGEN AND LIQUID ARGON. Pellett, D.; Stump, R. (Kansas Univ., Lawrence). Aug. 1962. 2p. (AFOSR-J-975). CFSTI.

There are only a few elements which form colorless liquids suitable for use in bubble chambers. The operating parameters of some of these, i.e. hydrogen, deuterium, helium and xenon, are well known. The operating parameters for two liquefied gases of intermediate atomic number, argon and nitrogen are reported. Both are quite suitable for bubble chamber use, being non-corrosive, non-explosive and readily available. Since both are sensitive at a temperature above the normal boiling point of liquid nitrogen, the cryogenic requirements are not severe. (auth) (USGRDR)

31548 ON THE PROCESSING OF BUBBLE CHAMBER TRACKS BY MEANS OF IN-LINE FILTERED HOLOGRAPHY. Murata, Kazumi; Fujiwara, Hirofumi (Hokkaido Univ., Japan). Mem. Fac. Eng., Hokkaido Univ., 12: 329-42(Jan. 1969).

Some fundamental problems for the application of an in-line Fraunhofer holographic technique to the recording of the bubble chamber tracks were studied. Optical spatial filtering based on the double diffraction method was combined with the recording and reconstructing processes of the bubble chamber holography in order to suppress undesirable beam tracks. Experimental studies were conducted using simulated conditions of bubble chamber tracks and actual bubble-chamber photographs. The results showed some promise of success for using the in-line Fraunhofer holography to bubble chamber photography. (auth) (NSA of Japan)

31549 PULSE SHAPE DISCRIMINATOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1861).

2 drawings.

A pulse shape discriminator used to measure flux density, energy, and the direction and location of high-energy electrons and protons is described. The angular distribution of these particles relative to the Earth's magnetic field can be measured. The instrument is part of the payload used in OSO-4 satellites. (For details see TID-4100, Suppl. 53). (See also CAPE-1428). (F.S.)

31550 BUBBLE CHAMBER FILM MEASURING SYSTEM EMPLOYING HIGH ACCURACY IMAGE PLANE DIGITIZERS. Hill, D. G.; Palmer, R. B. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 40: 878-83(July 1969).

A bubble chamber film measuring system is described. Measurement is performed manually on the projected image employing an essentially bipolar coordinate system. The lengths of wires between the measured point and the two drums are determined from the rotation of the two drums which are mounted on optical angle encoders. The accuracy of the system when measuring test grids is $\pm 4\ \mu$ on film. The measuring device and the procedure, speed, and accuracy of measuring bubble chamber events are discussed. (auth)

31551 IONIZATION MEASUREMENTS IN A HELIUM STREAMER CHAMBER. Kanofsky, A.; Schoen, N. (Lehigh Univ., Bethlehem, Pa.). Rev. Sci. Instrum., 40: 921-3(July 1969).

A measurement of the density of ionization produced in a helium streamer chamber by singly charged particles as a function of momentum, helium pressure, and high voltage delay time is described. The results are compared with expected theoretical values based on the Bethe formula. (auth)

31552 CALCULATION OF RADIATION CORRECTIONS FOR PULSED ELECTRONS. Pershin, I. I.; Shishov, N. N.; Shkurenko, Yu. P. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 1, 30-5(Jan.-Feb. 1969). (In Russian).

The question concerning the calculation of radiation corrections to the momentum of electrons according to photographs of tracks in heavy liquid bubble chambers with magnetic fields was examined. A formula was obtained for the statistical analysis of the average value of the cutoff parameter $\overline{Y}_0$, corresponding to approximate measurements of the radius of the trajectory, and establishing the relation of the quantity $\overline{Y}_0$ with the length of the track L, the intensity of the magnetic field, and the radiation length of the working liquid X_0. According to two series of photographs from the 120-liter bubble chamber of the Inst. of Theoret. and Exper. Physics the momentum of electrons from pair production, which arose from quanta, emitted from the decay of π-mesons, was measured. The first of these series was obtained from the chamber, which was filled 50% (by weight) with a mixture of propane and SF_6, and magnetic field of ~7 kG. The second series was obtained with chambers filled 50% (by weight) with a mixture of propane and xenon, and a magnetic field of ~18 kG. Using the measured values of the momentum, the effective mass of two quanta $M_{\gamma\gamma}$ was calculated. The average value $\overline{M}_{\gamma\gamma}$ corresponding to the mass of π-mesons only after the introduction of radiation corrections according to the formulas of Behr and Mittner (Nucl. Inst. and Methods, 20: 446(1963)). For the estimates of correction there was used the value of the cut-off parameter, found according to an approximation formula. (tr-auth)

31553 COMBINED OPERATION OF SPARK CHAMBERS AND IONIZATION CHAMBERS. Bostandzhyan, N. Kh.; Vardumyan, D. T.; Marikyan, G. A.; Matevosyan, K. A.; Oganesyan, A. P. Prib. Tekh. Eksp., No. 1, 43-6(Jan.-Feb. 1969). (In Russian).

In the apparatus described, which is intended for the investigation of nuclear interactions of cosmic rays, the combined operation of spark chambers and ionization chambers is utilized. Spark chambers were developed which keep a high efficiency (>35%) upon delay of starting pulses (~30 μsec). The question concerning the measurement of pulses from ionization chambers upon the passage of ≥ 20 particles through them for the synchronization of spark chambers with operating voltage 50 kV was examined. (tr-auth)

31554 HIGH-VOLTAGE NANOSECOND PULSE GENERATOR. Knyazev, V. M.; Lyubimov, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 1, 82-4 (Jan.-Feb. 1969). (In Russian).

A 26-cascade high-voltage pulse generator was described for use with streamer spark chambers with 0.5 m spacing. The generator produces pulses with duration of 16 nanoseconds and nominal amplitude of 1 MV. (tr-auth)

31555 MAGNETOSTRICTION MATERIALS FOR THE READ-OUT OF INFORMATION IN FILM-LESS SPARK CHAMBERS. Bespalova, T. V.; Golutvin, A. I.; Zanevskii, Yu. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 1, 40-3(Jan.-Feb. 1969). (In Russian).

Experimental data are presented on amplitude and frequency characteristics of magnetostrictive materials used for readout of information in film-less spark chambers. (tr-auth)

Radiation Dosimeters

Refer also to abstract 31366.

31556 (AD-682198) THE QUALITY AND LET DEPENDENCE OF THREE THERMOLUMINESCENT DOSIMETERS AND THEIR POTENTIAL USE AS SECONDARY STANDARDS. Tochilin, Eugene; Goldstein, Norman; Lyman, J. T.; Miller, William G. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 7, 1968. 23p. (USNRDL-TR-68-129). CFSTI.

The energy dependence of thermoluminescent dosimeters was investigated over a range of x- and gamma-ray energies extending from 6 to 2750 keV. Radiation sources included filtered x rays and isotopes emitting gamma rays of known energies. In order to correlate the energy deposited in the phosphor with light output, the measured response was compared with the computed value of absorbed dose. A systematic increase in light output with decreasing photon energy was observed for all phosphors: this was interpreted as an LET effect. The LET dependence of these phosphors was then investigated with accelerator-produced charged particles for LET values from 0.25 keV/micron to beyond 1000 keV/micron. Response curves are presented which allow the use of LiF and $Li_2B_4O_7$ Mn as secondary standards to measure absorbed dose or exposure. The use of this method for x- and gamma-ray measurements down to 6 keV is described. Calibration is by means of a ^{60}Co gamma-ray standard. (auth) (USGRDR)

31557 (AD-682721) NEUTRON SENSITIVITIES OF VARIOUS GAMMA DOSIMETERS. Stuetzer, Max; Gibson, Nancy N. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Dec. 1968. 25p. (NDL-TM-52). CFSTI.

The neutron sensitivities of silver-activated metaphosphate glass, manganese-activated calcium fluoride thermoluminescent dosimeters, and lithium fluoride thermoluminescent dosimeters have been measured for six neutron energies ranging from 1 to 14.6 MeV. Preliminary data from these experiments have been presented. Errors were introduced by the low intensities of the experimental neutron fluences and by gamma contributions to dosimeter responses. A first-order approximation of the gamma contributions was made and used to correct experimental data. The neutron sensitivities reported have been successfully applied to correct gamma-exposure data from three recent wagon effects experiments. (auth) (USGRDR)

31558 (AD-684230) DESIGN AND RADIATION CHARACTERISTICS OF A PROBE FOR MEASUREMENTS OF LOW-LEVEL GAMMA RADIATION AND BETA CONTAMINATION. Jager, W. F. (Admiralty Research Lab., Teddington (England)). Dec. 1968. 30p. (ARL/C/R-24; NSTIC-20229/69). CFSTI.

The design and characteristics of a probe, incorporating Geiger-Mueller tubes, for the measurement of gamma radiation dose-rate and the indication of surface contamination by mixed fission products are described. Particular features are the wide range of dose-rates measured (0.1-1,000 mrad/hr) and the uniformity of response over a photon energy range of 80 keV to 1.25 MeV. (auth) (USGRDR)

31559 (AD-684772) ELECTRON X RAY AND GAMMA-RAY MEGARAD DOSIMETRY WITH COLORED PLASTIC. Goldstein, Norman; Miller, William G. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 3, 1968. 18p. (USNRDL-TR-69-7). CFSTI.

Two cinemoid color mediums, purple and bright rose, were calibrated as radiation detectors. The dyed plastic undergoes optical changes in the visible spectrum for exposures between 10^5 and 10^7 R. Measurement of optical change was simplified with the use of densitometer instead of spectrophotometer readout. The changes obtained with the densitometer color filters were only slightly decreased from those obtained with the spectrophotometer set at the wavelength of optimum color change. Moisture content had some effect on both cinemoids whereas oxygen content effected only the exposure of the purple cinemoid. The bright rose cinemoid was found useful for measuring pulsed and steady-state electron exposures and for measuring gamma-ray exposure in a mixed gamma ray-neutron field. (auth) (USGRDR)

31560 (AD-684824) MINIATURE TISSUE-EQUIVALENT IONIZATION CHAMBER FOR PULSE DOSIMETRY. Kuritzky, C. S.; Shonka, F. R.; Wyckoff, H. O.; Pfeiffer, W. F. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Nov. 1968. 19p. (AFRRI-TN-68-9). CFSTI.

For radiobiological purposes it is desirable to measure the absorbed dose in the material of interest with a high degree of accuracy and precision. In regions of large spatial variation it is important that the detector be as small as possible. To meet both requirements a miniature three-terminal tissue-equivalent ionization chamber was designed. It was produced by using injection molding and ultrasonic welding techniques. The chamber has an outside diameter of 5.5 mm and an ionizing volume of approximately 0.01 cu cm. The chamber was exposed to pulses from the AFRRI-TRIGA reactor to evaluate its collection efficiency and precision. For 100,000-rad pulses with peak dose rates of 10 million rads per second the collection efficiency was measured to be 85 percent. For 7000-rad pulses the collection efficiency was 98 percent. The precision of the chamber for fifteen 1000-rad pulses gave a standard deviation of 0.2 percent. (auth) (USGRDR)

31561 (AD-684910) THERMOLUMINESCENT DOSIMETRY AND ITS USE AT THE US ARMY NUCLEAR DEFENSE LABORATORY. Gibson, Nancy N.; Crimmins, Thomas W.; Conley, Kenneth D.; Jacobson, John R. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Nov. 1968. 33p. (NDL-TM-49). CFSTI.

The report discusses CaF_2: Mn and LiF thermoluminescent dosimeters (TLD). CaF_2: Mn vacuum tube TLD and ½ mini TLD provide reliable gamma-exposure measurements from 5,000 to 50,000 R. Used with energy discrimination and ^6LiF thermal neutron shields, the TLD are energy independent and thermal neutron insensitive. The LiF TLD rods provide inexpensive tissue-equivalent measurements of gamma radiation from 10 to 10,000 R. Thermal neutron response can be made insignificant by using ^7Li enriched phosphor. Numerical corrections can be made for fast neutron contributions to LiF and CaF_2: Mn TLD response. (USGRDR)

31562 (INR-963) SOME PRELIMINARY PROJECT STUDIES ON THE SEQUENTIAL RECOGNIZING SYSTEMS OF STRAIGHT TRACKS IN MONITORING NUCLEAR FILM-BADGES. Korbel, K. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 23p. Dep.

Two automatic readout systems for particle tracks in nuclear film badge monitors are presented. Both sequential type systems recognize straight tracks exceeding the determined minimum length within an acceptance angle of 90° in the image plane. (auth)

31563 (UCRL-50007-68-3, pp 1-5) THERMOLUMINESCENT EMISSION SPECTRUM OF LiF. Wilson, C. R.; Jones, D. E. (California Univ., Livermore. Lawrence Radiation Lab.).

The thermoluminescent emission spectra of highly purified LiF were found to peak at 590 nm, while regrown crystals of this material were found to have their maximum emission shifted to shorter wavelengths near 400 nm. (auth)

31564 (UCRL-50007-68-3, pp 12-17) REMOTE AREA MONITORING (RAM) ARRAYS FOR CLOSE-IN MONITORING DURING UNDERGROUND NUCLEAR TESTING. Prevo, C. T.; Rich, B. L. (California Univ., Livermore. Lawrence Radiation Lab.).

A theoretical study is made of the lower limit of detectability and the accuracy of remote area monitoring (RAM) arrays for close-in monitoring during underground nuclear testing. (auth)

31565 (UCRL-50007-68-3, pp 25-34) PARAROSANILINE CYANIDE FOR HIGH-LEVEL DOSIMETRY. Sanborn, E. N. (California Univ., Livermore. Lawrence Radiation Lab.).

A method that uses pararosaniline cyanide to make a calorimetric dosimeter for measuring x and gamma radiation in the megaroentgen range is described. (auth)

31566 (UCRL-50007-68-3, pp 59-64) ENERGY DEPENDENCE CHARACTERISTICS OF THE NEW LRL PERSONNEL DOSIMETER. Samardzich, B. G. (California Univ., Livermore. Lawrence Radiation Lab.).

The energy dependence of the new LRL lithium fluoride thermoluminescent personnel dosimeter for gamma and x radiation is discussed. (auth)

31567 "DOZA" ELECTRONIC ANALOG COMPUTING DEVICE INTENDED FOR ESTIMATING DOSE FIELDS IN AN IRRADIATED PERSON'S BODY. Ushakov, V. B.; Golovan, V. A.; Efremova, E. F.; Kozlova, A. I.; Shagimardanov, N. Sh. pp 80-9 of Analogovaya i Analogo-Tsifrovaya Vychislitel'naya Tekhnika, Sbornik Statei. Moscow, Izdatel'st-vo Sovetskoe Radio, 1968. (In Russian).

A new special-purpose analog computer, the "Doza," was developed by the Moscow Scientific Research Institute of Computer Construction (NII Schetmash) for the purpose of estimating isodose patterns and for studying the distribution of dose fields in anatomical cross-sections. The "Doza" calculates the distribution of a dose field inside a multifield-irradiated circle as a function of the source radiation energy, source-skin distance, and irradiation-field area. The total doses are estimated at the intersections of a rectangular coordinate net with 1-cm squares. The "Doza" includes: (1) an analog computer proper which calculates, according to a specified algorithm, the percent depth of the dose, at a specified point of the cross-section, caused by one irradiation field;

(2) input units which receive all initial data as voltages; (3) output units which yield digital information and also patterns drawn on paper; (4) a sync unit which ensures synchronous input of quantities that vary in the course of solution; and (5) a control panel. The technical characteristics of the "Doza" are: source-skin distance, 0–100 cm; depth of tumor, 0–25 cm; number of irradiation fields, 0–24; irradiation-field dimension, 0–20 cm; source energy, 0–25 MeV. An example of dose distribution is shown: a lung-cancer seat is ^{60}Co gamma-irradiated from 7 fields. (JPRS)

31568 COMMENT ON THE APPLICABILITY OF A SOLID STATE BRAGG–GRAY CAVITY CHAMBER TO THERMOLUMINESCENT DOSIMETRY. Burlin, T. E.; Chan, F. K. (Regent Polytechnic, London). Int. J. Appl. Radiat. Isotop., 20: 398(May 1969).

Reference is made to the paper by Nakajima (loc. cit. 19: 789 (1968)) on the use of thermoluminescent materials embedded in resin to form very thin disks for small volume and interface dosimetry. Nakajimas theoretical interpretation of the light output of such a system when surrounded by different materials is discussed. (UK)

31569 APPLICATION OF THERMAL-STIMULATED EXO-ELECTRON EMISSION FOR DOSIMETRY OF IONIZING RADIATION. Beskorskii, A. I.; Zhegalina, G. A.; Goikhberg, E. Ya. Prib. Tekh. Eksp., No. 1, 36-9(Jan.-Feb. 1969). (In Russian).

The application of thermal-stimulated exo-electron emission for dosimetry of ionizing radiation was examined. The results of an investigation of dosimeters with different exo-electron emitters were given. (tr-auth)

Radiometric Instruments

Refer also to abstract 31494.

31570 (INR–974) INFLUENCE OF LEAKAGE CONDUCTANCE ON IONIZATION SMOKE DETECTORS. Machaj, Bronislaw (Institute of Nuclear Research, Warsaw (Poland)). 1968. 12p. (In Polish). Dep.

Relations determining correlation of parameters of ionization smoke detectors have been derived and with their help the influence of leakage conductance discussed. (auth)

31571 RADIOMETRIC ANALYSIS OF POWDERED SAMPLE MATERIAL. Starnes, Peter Edward (to Hilger and Watts Ltd.). U. S. Patent 3,445,651. May 20, 1969. Filed July 6, 1964.

An apparatus for testing powdered sample material by radiometric analysis which includes a movable sample carrier, a method for feeding the powdered sample to the carrier, a method for forming a layer or ribbon of the sample on the carrier of substantially constant mass per unit area and substantially constant thickness and width, a method for continuously measuring the weight of the sample on the carrier, a method for regulating the rate of feed of the sample to the carrier in order to maintain the weight of the powdered material substantially constant, a source of radiation past which the sample layer can be moved by the carrier at a substantially constant distance from the source so as to be irradiated and a method for measuring the resultant radiations emanating from the sample material is described. (Offic. Gaz.)

31572 THE APPLICATION OF RADIOACTIVE SOURCES OF SOFT X-RAYS FOR THE MEASUREMENT OF THICKNESSES OF THIN COATINGS. Lobov, S. I. Prib. Tekh. Eksp., No. 1, 180–4(Jan.-Feb. 1969). (In Russian).

The soft x rays from T and ^{55}Fe were used for the measurement of thin metallic coatings of thicknesses 0.01–5 mg/cm^2. The thickness of the coatings was determined by the intensity of the characteristic x rays or by dispersion of x rays from the support material, the support material and applied coating, and the coating itself. The radiation was detected using a Geiger–Mueller counter. The thicknesses of the coatings were measured for the following combinations of metals: Cu on Al; Al on Fe; Tl and Cd on Ti; Au on Sn; and Ag and Au on Fe. The maximum absolute sensitivity for these combinations reached was 5 μg/cm^2. (tr-auth)

Miscellaneous Instruments and Components

Refer also to abstracts 32101 and 33095.

31573 (K–1774) SOLID STATE DIRECT-CURRENT AMPLIFIER SYSTEM FOR MASS SPECTROMETRY. Sulfridge, Clint; Langdon, Aubrey (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 6, 1969. Contract W-7405-eng-26. 7p. Dep. CFSTI.

A direct-current amplifier system has been developed for use in dual-collector mass spectrometers measuring ion ratios. The two dc amplifiers in the system are similar to one described by Leck and Austin, except for using solid-state electronic power supplies instead of batteries. The amplifiers have been adapted to the type 5886 electrometer preamplifier tube frequently used in mass spectrometers. The noise level and drift rate are equal to the best obtainable with vacuum tube amplifiers, and long, trouble-free service is experienced. (auth)

31574 (LA–4121) RADIATION LEAKAGE THROUGH PINHOLE COLLIMATORS. Moore, B. M. (Los Alamos Scientific Lab., N. Mex.). Feb. 1969. Contract W-7405-eng-36. 5p. Dep. CFSTI.

A method is described for determining the increased signal from a point source due to radiation leakage through the sides of a pinhole collimator. The method enables quick estimates of the leakage, with fairly small uncertainties, for many source, collimator, and detector systems. (auth)

31575 (RD/B/N–1263) MODIFICATION OF THE B,N,L. 250-kV X-RAY SET AND THE RECALIBRATION OF ITS OUTPUT. Lavender, A.; Thompson, I. M. G.; Shipton, R. G.; Goodwin, J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1969. 20p. Dep.

The 250 kV x-ray set operated at Berkeley Nuclear Labs. for health physics instrument calibration and assessment was modified and its output recalibrated. Measurements of the spectra led to a modification of two of the filter combinations used. A description of a voltmeter installed to measure the tube potential is given. The addition of the voltmeter circuit leads to stable tube operation at lower currents than previously obtainable. The use of the voltmeter also enables the beam conditions to be adequately defined over a wider range of working exposure rates. A comparison was made between the National x-ray Standard and the secondary instrument used in the CEGB facility. (auth) (UK)

31576 (SC-DR–69-240) DETERMINATION OF BREMSSTRAHLUNG PRODUCTION EFFICIENCIES FROM DATA OBTAINED ON PHERMEX AT 27 MeV. Martin, T. H. (Sandia Labs., Albuquerque, N. Mex.). May 1969. 9p. Dep. CFSTI.

Recent experiments conducted at Los Alamos Scientific Laboratory on the PHERMEX installation and analyzed with a Sandia Laboratories computer program indicate that the generally accepted bremsstrahlung production efficiency versus voltage curve needs corrections at voltages above approximately 13 MeV. Analysis of the data shows that electron beam divergence angles must be taken into account and subsequently indicates that a 2-degree average beam divergence angle exists on PHERMEX. When the beam divergence is eliminated the bremsstrahlung production efficiency curve can be represented by the relatively simple equation $D/Q = 1.1 \times 10^3 V^{2.8}$, for at least $1 \leq V \geq 27$ where V is given in megavolts, D in roentgens, and Q in coulombs. (auth)

31577 (SC-RR–69-241) A COMPUTERIZED METHOD OF PREDICTING ELECTRON BEAM BREMSSTRAHLUNG RADIATION WITH SPECIFIC APPLICATION TO HIGH VOLTAGE FLASH X-RAY MACHINES. Martin, T. H. (Sandia Labs., Albuquerque, N. Mex.). May 1969. 41p. Dep. CFSTI.

Many interesting phenomena occurring in the radiation output of large flash x-ray machines can be utilized only by understanding the action of the incident electron stream on the target. The detailed calculations required to understand these effects are best performed with a computer. The computer program utilized is explained, and the outputs obtained are tabulated. The report also draws conclusions for future research, analysis, and machine design. Interrelationships are developed between the switch rise time, the radiation pulse length, the dose expected at 1 meter, and the dose distribution. (auth)

31578 ION SOURCE WITH ELECTRON BOMBARDMENT NOT REQUIRING A SOURCE AUXILLIARY MAGNETIC FIELD. STUDY OF THE ELECTRON BEAM CHARACTERISTICS WHEN OPTIMUM FOCUSING CONDITIONS ARE ACHIEVED. Chantreau, Jean (Faculte des Sciences, Poitiers, France). Rev. Phys. Appl., 4: 13-20(Mar. 1969). (In French).

A mass spectrometer ion source of the Nier type without auxiliary magnetic field was constructed. Experimental and theoretical studies of focalizing conditions for the ionizing electron beam were reported previously. The calculation of the thickness of the electron sheet all along the electron accelerating system is considered for voltages ranging from 100 V to 1,000 V taking into account the initial velocity of electrons, space-charge being neglected. (auth)

31579 TRACTION MICRO-MACHINE FUNCTIONING AT LOW TEMPERATURES. Conte, Rene-Rolland; von Stebut,

Juergen (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Rev. Phys. Appl., 4: 70-4(Mar. 1969). (In French).

A tensile machine of very small size (ϕ = 12 mm, L = 120 mm) designed to operate in the Triton reactor at 20°K is described. In situ measurements of stress, strain, an electric resistance on a specimen of L ≤ 30 mm in length are made possible. The maximum load that can be applied is 1.4 kg, the maximum elongation obtained is 0.7 mm. This device is suited in particular for the measurement of the change in resistance of a specimen caused by elastic deformation. (auth)

31580 QUADRUPOLE FIELD IN CIRCULAR CONCAVE ELECTRODES WITH FINITE THICKNESS. Hayashi, Tomonao; Sakudo, Noriyuki (Tokyo Univ.). Rev. Sci. Instrum., 40: 923-4(July 1969).

The influence of the finite thickness of circular concave quadrupole electrodes on the spatial higher harmonics is investigated. A design curve for obtaining the proper electrode angle to best approximate the quadrupole field is given by analyzing the results of field plotting. The residual higher harmonics which are mainly due to the 20-pole field component are confirmed to be negligibly small in the vicinity of the axis. The effect of the finite size of the conducting paper used in the field plotting on the measured amplitude of the spatial higher harmonics is also estimated. (auth)

31581 TRANSIENT RESPONSE OF MAGNETIC PROBES. Ferrari, L. A. (Queens Coll., New York. Brookhaven National Lab., Upton, N. Y.); Zucker, M. S. Rev. Sci. Instrum., 40: 925-6 (July 1969).

The response of a magnetic probe to a source that varies harmonically with time is calculated including transient effects. It is found that when the applied frequency is 10% of the natural resonant frequency of the probe the maximum distortion in the integrated signal is ≈10%. (auth)

31582 AUTOMATED RETARDING POTENTIAL DIFFERENCE TECHNIQUE USING A MULTICHANNEL SCALER. Chantry, P. J. (Westinghouse Research Labs., Pittsburgh). Contract NONR-2584(00). Rev. Sci. Instrum., 40: 884-9 (July 1969).

A commercially available multichannel analyzer, used in the multiscaling mode, has been adapted so as to accumulate automatically data from electron beam experiments employing the retarding potential difference (RPD) technique for improving the electron energy resolution. The electron accelerating voltage is generated by digital-to-analog conversion of the live channel address, the lower and upper limits of the sweep being adjustable over a wide range. The analyzer is swept alternately in the add and subtract modes with a period which is short compared to possible drifts in electron current, collision chamber pressure, multiplier sensitivity, etc. The tedious labor involved in obtaining RPD data by conventional means, and its subsequent arithmetic reduction, is all performed automatically by the analyzer. Examples of data obtained by the technique are presented, showing the improvement in signal to noise obtainable by operating for a suitably large number of sweeps. (auth)

31583 IMPROVED COLLIMATOR FOR EXTREME ULTRAVIOLET AND X RAYS. Underwood, J. H. (Goddard Space Flight Center, Greenbelt, Md.). Rev. Sci. Instrum., 40: 894-6 (July 1969).

The mechanical collimator for x rays and extreme ultraviolet described by McGrath may be improved by replacing the plates pierced with apertures arranged in a regular array with plates pierced with apertures arranged at random. With this scheme, fewer plates are required to suppress off-axis radiation. (auth)

31584 A LINEAR POLARIZATION DIPLEXER AT 34 GHz. Rhinewine, M. (Bell Telephone Labs., Inc., Whippany, N. J.). Rev. Sci. Instrum., 40: 951-2(July 1969).

Studies have been made of microwave scattering from turbulent plasma. In the course of these studies it became necessary to measure the degree of depolarization of the scattered wave. For this purpose a turnstile junction was developed that could separate the orthogonal linearly polarized components of 8.8 mm waves. The isolation was greater than 30 dB. (auth)

31585 GROOVED CRYSTAL SPECTROMETER ATTACHMENT FOR X-RAY ABSORPTION MEASUREMENTS. Alexandropoulos, N. G. (Polytechnic Inst. of Brooklyn). Rev. Sci. Instrum., 40: 952-4(July 1969).

In an effort to carry out precise measurements on the mass absorption coefficients and later to study the effect of the polarized x rays on absorption, an instrument has been developed which has given results in studies of Al, Fe, and Si which are very close to the theoretical values given by Guttmann and Wagenfeld (Acta Cryst., 22: 339(1967)). The instrument is a grooved crystal of Ge or Si which is placed on the rotation axis of a diffractometer with the groove parallel to the plane (220). The beam, after collimation, will be monochromatized by that side of the grooved crystal nearest the target (part A) with planes (220) and (2$\bar{2}$0) parallel to the rotation axis of the diffractometer. This axis passes through the center of the grooved crystal. The crystal is adjusted to the Laue transmitted position (Bormann position) so that the first part of the crystal acts as a monochromator and polarizer while the further side of the grooved crystal (part B) is the analyzer. The sample, placed in the groove of the crystal, can be either solid or liquid. (auth)

31586 MINIATURIZED STRESS RELAXATION APPARATUS FOR USE IN RADIATION FIELDS. Tanny, Gerald; Trudel, Gerald J.; St. Pierre, Leon E. (McGill Univ., Montreal). Rev. Sci. Instrum., 40: 957-8(July 1969).

In order to study radiation induced changes in elastomers, an accurate instrument was developed for use in a confined space such as the radiation cavity (16 cm dia and 20 cm high) of a Gammacell 220. Furthermore, it was desirable to have a relaxometer capable of operating in both the continuous and intermittent mode and under a wide variety of environmental conditions. It was therefore necessary to assemble a miniature relaxometer. The instrument is thought to be sufficiently versatile to be applicable to a wide variety of experimental problems. The relaxometer consists of a load sensing element, a variable extensometer, and a thermostated environmental chamber. The load sensing element is a linear, nonbonded, strain gauge transducer with the appropriate load cell accessory and is equipped with radiation resistant cable leads. The excitation voltage, balancing resistors, and visual readout are provided by a Statham URB analog readout. (auth)

31587 PERMANENTLY EXCITED THERMOLUMINESCENCE SUBSTANCE. Spurny, Z. (Nuclear Research Inst., Prague). Int. J. Appl. Radiat. Isotop., 20: 395(May 1969).

Mixing a thermoluminescent phosphor with a radioactive element (for example, a long-lived beta-radioisotope) affords permanently excited matter which when heated gives luminescence. Thus, such a substance can serve as a detector of thermal energy or as a special illuminator. The thermoluminescence intensity depends on the nature of phosphor, on the dose of applied radiation and on the heating rate, and is a function of the radioisotope half-life. Using one of the best phosphors, $CaSO_4$(Mn), in a mixture with ^{32}P radioisotope a substance of very high thermoluminescence efficiency was prepared: beginning from about 50°C it gives visible light of yellow-green color. The method of preparation is described. (auth) (UK)

31588 PRIMENENIE TUNNEL'NYKH DIODOV V PRIBORAKH YADERNOI FIZIKI. (Use of Tunnel Diodes in Instruments for Nuclear Physics). Ivanov, A. A.; Kolpakov, I. F.; Timokhin, L. A. Moscow, Atomizdat, 1967. 209p.

This book is intended for design engineers of physical equipment, specialists concerned with physical experiments, and aspirants and students in schools of higher education. The book deals with special features of tunnel diodes and with methods of designing these devices and utilizing them in nuclear physics apparatus. Soviet and non-Soviet data on the application of tunnel diodes in individual assemblies of physical equipment including generators, shapers, discriminators, counters, logical networks, storage units, time selection circuits, and oscillators, are given. Circuits are recommended. (TSS) (JPRS)

31589 GYROMAGNETIC RESONANCE SPECTROMETER. Feeney, Jim (to Varian Associates Ltd.). British Patent 1,152,778. May 21, 1969. Filed June 16, 1967.

A gyromagnetic response spectrometer is described comprising means for exciting gyromagnetic resonance of a sample under analysis in a polarizing magnetic field by producing a radio frequency magnetic field in the sample at the resonance frequency of the sample, means for receiving the resonance signal emanating from the sample and detecting same to produce an output resonance signal, means for scanning the resonance-determining conditions of the spectrometer to produce an output resonance spectrum of the sample under analysis, said receiving means including an adjustable electric filter means, for adjusting said filter means to change the band of frequencies passed therethrough, means for adjusting the scan of said spectrometer scanning means, and means forming an integral part of said spectrometer for establishing one certain predetermined set of the aforecited adjustments to the exclusion of all other sets of adjustments to aid the operator in obtaining a standard output spectrum having certain standard predetermined characteristics. (auth)

31590 PROCEEDINGS OF THE 1969 ANNUAL SYMPOSIUM ON RELIABILITY, CHICAGO, ILLINOIS, JANUARY 21, 22, 23, 1969. Annals of Assurance Sciences, Volume 2, Number 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1969. 662p. $8.00. (CONF-690109).

A separate abstract was prepared for 1 of the 75 papers presented. The remaining 74 papers were not within the scope of NSA. (W.H.K.)

For an abstract of the individual paper see: 31595.

31591 MULTICHANNEL APPARATUS FOR REMOTE DETERMINATION OF THE INTENSITY OF CONSTANT MAGNETIC FIELDS. Kozin, V. P.; Tolstoi, A. E. (Physical-Technical Inst., Kharkov). Prib. Tekh. Eksp., No. 1, 165-8(Jan.-Feb. 1969). (In Russian).

A method based on nuclear nutation in flowing water is described for the remote measurement of the absolute value of the magnetic field in the range from average to strong intensity fields with gradients of ~1 kOe/cm. The apparatus permits remote measurements, from the operator's console, of the stability and intensity of the magnetic elements of a charged-particle injector of a linear accelerator. (tr-auth)

31592 ELECTROMETER AMPLIFIERS OF CONSTANT CURRENT FOR MASS SPECTROMETERS. Leporskii, B. B.; Zalesov, Yu. N.; Makarov, V. I. Prib. Tekh. Eksp., No. 1, 89-90(Jan.-Feb. 1969). (In Russian).

An electrometer amplifier for the ion current of mass spectrometers is described. The electrometric cascades in the amplifier were accomplished in an EM-6 tube. The fluctuations of the output voltage are ±0.2 to 0.25 mV for an input resistance of 10^{12} ohm and an input stage time constant of 1 sec. The drift does not exceed 0.5 mV for 8 hours. The output characteristics are linear up to 120V. (tr-auth)

31593 CHARACTERISTICS OF A PLASMA ELECTRON BEAM GUN. Ueyama, Yoshiji; Yasunaga, Seiji (Mitsubishi Electric Corp., Omiya, Japan). Mitsubishi Denki Lab. Rep., 9: 289-308(Oct. 1968).

A shielded solid metal type plasma electron beam gun has been constructed to develop a new source of electron beam as a heat source for the purpose of industrial application. Effects of the electrode geometry have been investigated concerning the stability, the beam quality, and the power efficiency. Stability of 1.5×10^{-2}/hr has been attained by use of automatic pressure control system. The beam quality has been improved so as to make the weld penetration on stainless steel twice the beam width at the beam power of 8 kilowatts. (auth) (NSA of Japan)

Radiation Effects on Instruments and Instrument Components

31594 (CEA-Bib-137) ACTION OF COSMIC RAYS ON HEAVILY DOPED SEMICONDUCTORS. Ozveaminian, Kazem (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 1969. 21p. (In French). Dep.

After a short survey of the nature and characteristics of cosmic rays, an analysis is given of their action on semiconductor junction devices. The degradation of the usual diodes and transistors is briefly described, while the case of heavily doped junctions is more thoroughly examined, pointing out the fact that they are more resistant to cosmic-ray damage. (auth)

31595 SELECTION OF RELIABLE RADIATION HARD COMPONENTS. Schmitz, Gary E. (Univac Federal Systems Div., St. Paul). pp 100-7 of Proceedings of the 1969 Annual Symposium on Reliability, Chicago, Illinois, January 21, 22, 23, 1969. New York, Institute of Electrical and Electronics Engineers, Inc., 1969. See CONF-690109.

The major environments treated are neutron and gamma radiation. The most outstanding effect of neutron bombardment on active devices is to reduce minority carrier lifetime, thus reducing the post neutron beta, while the most outstanding effect of gamma radiation is the generation of photocurrents in the base-emitter region. Components which minimize both of these effects and which continue to perform reliably in all other specified environments must be located. Outstanding among the construction features desired in radiation hardened components are small geometry, state of the art gain band width (f_T), and minimum base width. Additionally, integrated circuits should be dielectrically isolated. The search for the desired components may be reduced by using f_T as a gross indicator. Searching existing test data will further reduce the search. Testing and new development must be employed when a desired component is not available. Power devices and linear integrated circuits are the device types most difficult to harden. After selecting all system components and verifying their ability to perform in the specified radiation environment, the problem of ensuring that uniform hardness is maintained in quantity lots remains. Since this task has not previously been undertaken, the two methods outlined are presented as suggestions only, rather than as practical problem solutions. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 32777.

Basic Processes

Refer also to abstracts 31306 and 31307.

31596 (BNL-50116(Vol.1)) STRUCTURE, FUNCTION, AND EVOLUTION IN PROTEINS. Report of Symposium held June 3–5, 1968. Brookhaven Symposia in Biology Number 21. (Brookhaven National Lab., Upton, N. Y.). Feb. 1969. 258p. (CONF-680651-(Vol.1)). Dep. CFSTI.

In this first volume of the current Brookhaven Symposia Series, seven papers are presented on the structure, function, and evolution of hydrolytic enzymes. The three remaining papers discuss: the structural and evolutionary relations of ferredoxins in green plants and algae, photosynthetic bacteria, and nonphotosynthetic anaerobic bacteria; the phylogenetic relations of 20 species of cytochrome C; and the genetic mechanism permitting higher organisms to synthesize an apparently unlimited number of different antibodies. Radioactive tracer techniques and x-ray diffraction methods were employed in most of the investigations to determine the amino acid sequences in the proteins. (E.R.B.)

31597 (BNL-50116(Vol.2)) STRUCTURE, FUNCTION, AND EVOLUTION IN PROTEINS. Report of Symposium held June 3–5, 1968. Brookhaven Symposia in Biology Number 21. (Brookhaven National Lab., Upton, N. Y.). Feb. 1969. 170p. (CONF-680651-(Vol.2)). Dep. CFSTI.

In this second volume of the current Brookhaven Symposia Series, seven papers are presented. The first paper is on the molecular expression of evolutionary phenomena in cytochrome C, the next two are on the structure and evolution of immunoglobulins and the structure and diversity of antibodies. The fourth and fifth papers deal with the chemistry of the structural proteins elastin and collagen. The sixth paper is on the activity of glutamine synthetase in Escherichia coli and the seventh on the α-beta acid dehydrogenase complexes. A list of participants and a speaker and subject index are provided at the end of this volume. (E.R.B.)

31598 (UCRL-50007-68-3, pp 17-20) ESTIMATION OF INHALED PARTICLE SIZE OF $^{239}PuO_2$ BASED ON THE NEW LUNG MODEL AND BIOASSAY RESULTS. Myers, D. S. (California Univ., Livermore. Lawrence Radiation Lab.).

A technique is presented to estimate the aerodynamic particle size of inhaled $^{239}PuO_2$ from bioassay results by relating initial gastrointestinal tract clearance (days 1 and 2) to late gastrointestinal tract clearance (2 weeks after exposure). This technique is based on theoretical considerations of the new lung model. (auth)

31599 USE OF INSOLUBLE ANTIBODY FOR QUANTITATIVE DETERMINATION OF SMALL AMOUNTS OF IMMUNOGLOBULIN. Mann, Dean; Granger, Harriet; Fahey, John L. (National Cancer Inst., Bethesda, Md.). J. Immunol., 102: 618-24(Mar. 1969).

A quantitative inhibition test for individual proteins was developed using ^{125}I-protein and insoluble antibody. Antibodies, reacting specifically with individual human immunoglobulins (IgG, IgA, IgM, κ or λ), were made insoluble by coupling to bromacetyl cellulose. Radioiodinated immunoglobulins were used with insoluble antibody in quantitative inhibition tests to measure the human immunoglobulins. The test is rapid, gives reproducible results, and is more sensitive than gel diffusion precipitation assays. (auth)

31600 AN IN VITRO BIOASSAY FOR THYROTROPHIN (TSH). Manley, S. W.; Bourke, J. R.; Hawker, R. W. (Univ. of Queensland, Brisbane). Endocrinology, 84: 1286-91(May 1969).

The depression of ^{131}I concentrating activity in propylthiouracil (PTU)-blocked guinea pig thyroid slices was utilized for the assay of TSH. The control iodide space was determined for each slice after 16 hr equilibration; TSH doses were then added and allowed to act for 10 hr. The effect metameter (the ratio of final to control T/M) eliminated variation due to non-uniformity of the mass of functional tissue assigned to each tube. High sensitivity and initial uptakes of 50 to 75% required for maximal precision were achieved by using thyroid tissue from guinea pigs treated chronically with PTU and withdrawn from goitrogen 72 hr before assay. The dose range for optimal precision extended from 1 to 64 μU International Standard TSH and from 2 to 16 μU human Research Standard A TSH (final concentration/ml in incubation medium). The limit of detection for TSH in unknown samples was about 0.5 mU/100 ml. Forty animals were tested in the assay to determine the homogeneity of the animal population with respect to sensitivity and precision. Two failed to respond significantly to the lowest dose employed. For the remaining 38 the mean index of precision L ($1/\lambda$) for the dose range 1.75 to 28 μU was 8.8 ($\lambda = 0.114$) with 79% of the L values being above 5 ($\lambda < 0.2$). Nonspecific responses that were not abolished by thyroxine pretreatment of donors or addition of antiserum occurred with unfiltered human serum and were of similar magnitude to those reported for other in vitro techniques. The Sephadex G-25 filtration procedure of Desbarats-Schönbaum et al. reduced the activity of euthyroid human serum to close to the limit of detection of the assay (mean 0.6 mU/100 ml Research Standard A). This response was not further reduced by either thyroxine pretreatment or addition of antiserum. Recovery of added human Research Standard A to human serum subjected to the filtration procedure was 95%. It was concluded that the level of euthyroid human serum TSH is less than 0.5 mU/100 ml. (auth)

31601 SOME EFFECTS OF DATA ERROR IN THE ANALYSIS OF RADIOTRACER DATA. Myhill, J. (Univ. of Sydney. Royal North Shore Hospital of Sydney, Crows Nest, Australia). Acta Radiol., Ther., Phys., Biol., 7: 443-52(Dec. 1968).

The effect of error in radiotracer data on the accuracy of derived parameters in two-compartment systems was studied. Computer simulation was employed to produce data with error of different magnitude for each of several values of rate constant and amplitude. The data were arranged to simulate experimental situations and analyzed by non-linear least squares. For a given error in the data the calculated errors in the rate constants and amplitudes were defined in terms of their ratios and the number and spacing of the data points. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 31330, 31725, 31728, 31729, 31741, 31743, 31745, 31764, 31831, and 31907–31912.

31602 (LF-39) FISSION PRODUCT INHALATION PROGRAM. Annual Report, September 1967–September 1968. McClellan, R. O.; Rupprecht, F. C. (eds.) (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1968. Contract AT(29-2)-1013. 263p. Dep. CFSTI.

The biological consequences of inhaling radioisotopes such as might be released in nuclear accidents were investigated, primarily in beagle dogs. Twenty-two separate abstracts were prepared for inclusion in NSA. Ten additional papers and a five-section appendix are included in the report for 1967–1968. These include papers on applications of instrumentation, basic analytical and physiological studies, and beagle dog colony breeding and experiences. Beagle status data are given in tables in the appendix along with a staff roster and lists of literature publications and technical reports. (C.O.)

For abstracts of individual papers see: 31299, 31327, 31603–31611, 31665, 31684, 31725, and 31906–31913.

31603 (LF-39, pp 76-83) TOXICITY OF INHALED ^{131}I IN RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Rats were exposed by inhalation to aerosols contaminated with ^{131}I or intravenously injected with solutions containing ^{131}I, resulting in initial body burdens of 20 to 1100 μCi/kg body weight. Whole-body counting, excreta and tissue analyses, and pathological examinations were performed to evaluate any retention differences or tissue changes due to route of administration or to initial ^{131}I body burden. Fifty to sixty percent of initially deposited ^{131}I was excreted during the first 24 hours after inhalation exposure or injection. With the exception of thyroid gland and pelt, all organs decreased in ^{131}I content the first day after inhalation exposure. Thyroid radioiodine increased during the first day to at least 3.2% of the initial body burden. Both transient and permanent changes, which were dependent upon the initial quantity of ^{131}I received, were observed histologically in thyroid gland. (auth)

31604 (LF-39, pp 105-14) LANTHANUM DISTRIBUTION KINETICS AND RADIATION DOSE FOLLOWING ADMINISTRA-

TION OF ^{140}La BY INHALATION, GAVAGE, AND INJECTION. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Lanthanum tissue distribution kinetics following inhalation and gavage of ^{140}LaCl and injection of ^{140}La in various chemical forms was studied in the Beagle dog. The solution of a kinetic model was presented describing the tissue distribution of ^{140}La after aerosol exposure. Tissue distribution patterns after injection of ^{140}LaCl in solutions at pH 3.5, 4.5, and 6.5 and ^{140}La-citrate were markedly different from those obtained after inhalation of ^{140}LaCl-contaminated aerosol particles. The results indicate that tissue distribution patterns are greatly influenced by the chemical nature of the La presented to biological system and that injection studies involving ^{140}La are of limited value for interpreting the results or predicting the fate of inhaled La. The highest radiation doses following inhalation of ^{140}LaCl-contaminated CsCl particles, with an Aerodynamic Median Activity Diameter of 1.8 μ are received by the nasal turbinates, lung, gastrointestinal tract, liver, skeleton and bronchial lymph nodes. (auth)

31605 (LF–39, pp 115-21) TISSUE DISTRIBUTION, EXCRETION, AND DOSIMETRY OF ^{95}Nb IN THE BEAGLE DOG AFTER INHALATION OF ^{95}Nb(V) OXALATE AND ^{95}Nb(V) OXIDE. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Niobium tissue distribution kinetics following inhalation of ^{95}Nb(V)-oxalate and ^{95}Nb(V) oxide was studied in the Beagle dog. About 60 percent of each aerosol was deposited in the respiratory tract of these animals, however, the subsequent ^{95}Nb tissue distribution patterns were markedly different. The ^{95}Nb inhaled as ^{95}Nb(V) oxide was either cleared from the upper respiratory tract within two days postinhalation or remained in the lung with a biological half-time greater than 300 days. Of the ^{95}Nb inhaled as ^{95}Nb(V) oxalate about 60% was cleared via the gastrointestinal tract, 23% remained in the lung with a biological half-time greater than 300 days and 17% was rapidly absorbed into the general circulation. The more significant rates of ^{95}Nb clearance from the general circulation occurred via renal clearance, endogenous fecal clearance, liver and skeleton. The highest radiation doses following inhalation of ^{95}Nb(V) oxide were received by the lung. (auth)

31606 (LF–39, pp 122-5) RADIOIODINE METABOLISM IN THE BEAGLE DOG: THE IMPORTANCE OF AGE AND MODE OF ^{131}I EXPOSURE. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The metabolism of ^{131}I was studied in the Beagle dog with reference to the effect of age (6, 18, and 48 month old dogs were studied), and the effect of route of administration, inhalation, ingestion, and intravenous injection. Three parameters were used to evaluate thyroidal ^{131}I metabolism; time to reach 90% of maximum uptake, maximum uptake, and the biological half-life of ^{131}I in the thyroid after maximum uptake. No statistically significant differences that could be related to age or route of administration were noted for any of the above parameters or in whole-body retention of ^{131}I. The lack of an age effect probably results from failure to study dogs less than 6 months of age. The lack of a route effect reflects the soluble nature of iodine in body fluids. (auth)

31607 (LF–39, pp 126-8) RETENTION OF ^{137}Cs ENTRAPPED IN FUSED-CLAY PARTICLES FOLLOWING INHALATION BY RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Rats inhaled an aerosol comprised of particles of montmorillonite clay into which ^{137}Cs had been entrapped by high-temperature fusion. Whole-body counting to >300 days post-inhalation indicated retention characteristics described by two power functions; an early phase having a slope of –0.38 and a later body loss described by a slope = –0.63. At least 95% of the ^{137}Cs burden was found to reside in the lungs, but some evidence of solubilization was indicated by a significant (but low) concentration in muscle. (auth)

31608 (LF–39, pp 129-35) EFFECT OF ZYMOSAN INJECTION ON BEHAVIOR OF INHALED PARTICLES IN RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Rats were given daily intravenous injections of either zymosan or 0.9% NaCl for six days and then exposed by inhalation to an aerosol of fused montmorillonite clay particles with ^{137}Cs entrapped. Whole-body counting provided initial and successive daily body burdens, and respiratory measurements during exposure allowed calculation of initial total deposition. Zymosan treatment increased breathing frequency and upper respiratory deposition of inhaled particles, resulting in a two-fold increase in initial clearance. After a few days, clearance kinetics were the same for both groups of animals and approximately 94% of the body content was localized in the lungs. Microscopically, increased numbers of RES cells with formation of numerous circumscribed nodules were found in the lungs, liver, spleen and bronchial lymph nodes of the zymosan-treated rats. Autoradiographs of the lungs showed bursts of radioactivity in alveoli and on bronchial mucosa during the first days post-inhalation; thereafter, activity increased in interstitial tissue, with no activity found at any time in RES nodules or in the thickened septal walls. (auth)

31609 (LF–39, pp 136-41) EFFECT OF STABLE YTTRIUM CARRIER CONCENTRATION ON THE METABOLISM OF INHALED RADIOYTTRIUM IN RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Groups of rats were exposed by inhalation to aerosols containing ^{88}Y as a radioactive tracer, either carrier-free or with stable ^{89}Y added in graded amounts to determine what effect the added carrier has on metabolic pathways. In all groups, the highest concentrations of ^{88}Y post-exposure were noted in liver, lung, and skeleton. The greatest differences in the tissue distribution pattern were seen when the carrier-free group was compared to that group receiving the largest amount of carrier (^{89}Y/^{88}Y = 1.8×10^5). In this case, at 32-days post-exposure the rats exposed to the highest concentration of carrier had 30% more of the whole-body ^{88}Y detected in the lungs and 28% less in their skeletons. Data from groups receiving intermediate amount of carrier indicate that the shift (from the carrier-free case) in tissue distribution is directly related to the concentration of ^{89}Y present. (auth)

31610 (LF–39, pp 142-7) THE INFLUENCE OF CHEMICAL STATE OF ^{144}Ce ON ITS METABOLISM FOLLOWING INHALATION BY MICE. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Mice were exposed by inhalation to ^{144}Ce-containing aerosols in the form of the chloride, the citrate, or entrapped in fused-clay particles. In the form of the entrapped radionuclide, ^{144}Ce behaves much like an insoluble material, residing predominantly in lung. When inhaled as the chloride or citrate, ^{144}Ce is more soluble in body fluids and a large fraction is translocated from lung to liver and skeleton. With all three forms, the bulk of ^{144}Ce excreted is found in the feces. (auth)

31611 (LF–39, pp 148-50) THE METABOLISM OF INHALED $^{241}AmO_2$ IN BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Beagle dogs were exposed by inhalation to an aerosol containing $^{241}AmO_2$. The metabolic behavior of the ^{241}Am was followed by periodic whole-body scanning and excreta analysis, using its 60 keV photon for detection. Results to date (41 days) indicate some solubilization of deposited material, as evidenced by appearance of ^{241}Am in the urine. The bulk of the body burden is localized in lung and has gradually assumed an extended residence time. The dose rate to the lung at this time is estimated to be 40 rads per day. (auth)

31612 (SZS–3/69) THE INHALATION OF RADIOACTIVE MATERIALS. III. URANIUM AND THORIUM. Literature Survey. Gensicke, F.; Nitschke, H.-W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Feb. 1969. 21p. (In German). Dep.

On the basis of 128 references a brief summary is given of the metabolic behavior of uranium and thorium after inhalation. Elimination is considered in particular. (tr-auth)

31613 RAPID UPTAKE OF RADIOSTRONTIUM IN SPERM. Aberg, B.; Crabo, B.; Ekman, L.; Loew, H.; Nyberg, J. A. (Royal Veterinary Coll., Stockholm. Karolinska Sjukhuset, Stockholm). Acta Physiol. Scand., 74: 381-3(Nov. 1968).

Strontium-85 ($^{85}SrCl_2$) was administered to rams and semen was collected. At 18 to 30 hrs after the i.v. administration of the radionuclide there was a maximal concentration in the spermatozoa. Five hrs after the administration the spermatozoal content of ^{85}Sr was higher than the seminal content. From the higher content in the spermatozoa than the seminal plasma it was concluded that there might be a considerable uptake of ^{85}Sr in the spermatozoa after ejaculation. This was also shown to be the case when $^{85}SrCl_2$ was added to fresh sperm in vitro. (auth)

31614 RADIOIODINE KINETICS OF THE THYROID GLAND AND THE CHANGES INDUCED BY L-TRIIODOTHYRONINE. Heinze, H. G.; Sonntag, A. (Univ., Munich). Med. Klin. (Munich), 63: 1102-5(July 1968). (In German).

Effects of L-triiodothyronine (T3) on ^{131}I turnover in the thyroid glands of patients were studied. Increased thyroidal ^{131}I turnover was observed in euthyroid patients and in those with primary hypothyroidism. It was concluded that the reasons for this were a re-

duced I pool in the thyroid and increased stimulation by thyrotropic hormone. Administration of exogenous T3 which extended the shortened thyroid ^{131}I effective half value time indicated that the cycling of ^{131}I was normal in euthyroidism and primary hypothyroidism. The results indicated that an increased thyrotropic stimulation probably was the reason for acceleration of ^{131}I turnover, and that lessening of the thyroidal I pool was not the sole cause. (BBB)

31615 BINDING OF TRACE AMOUNTS OF IONIC ^{113m}In TO PLASMA TRANSFERRIN. Hosain, Fazle; McIntyre, Patricia A.; Poulose, Kattadiyil; Stern, Howard S.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore, Md.). Clin. Chim. Acta, 24: 69-75(Apr. 1969).

Experimental observations demonstrating that ^{113m}In in plasma binds both in vivo and in vitro to transferrin are reported. About 6 mCi of carrier-free $^{113m}In^{3+}$ (about 0.0004 μg) was eluted with 8 ml of 0.05 N HCl from a $^{113}Sn-^{113m}In$ generator. One ml of 20% gelatin was added and the mixture was made isotonic by adding 0.5 ml of 12% NaCl solution and titrated to pH 2.5. Patients studied by cardiac scans because of suspected pericardial effusion received about 3 mCi of the ^{113m}In preparation intravenously. The pre-injection plasma was incubated for 5 min with 4 μC of ^{59}Fe or with the blood pool scanning agent containing about 100 μCi of carrier-free ^{113m}In. Starch gel electrophoresis was performed simultaneously on these two in vitro labeled plasma samples, the 5-min postinjection sample, and the ^{113m}In gelatin solution. The plasma sample with ^{59}Fe located the transferrin band in the starch gel. The distribution of ^{113m}In in plasma labeled either in vitro or in vivo was the same as that of ^{59}Fe-labeled plasma. Protein stains of these three plasma samples were similar. These observations suggested that ^{113m}In was bound to the transferrin in both in vitro and in vivo interactions with plasma. The ^{113m}In-gelatin preparation moved a shorter distance when electrophoresed in the absence of plasma. Indium-113m decays by isomeric transition with the emission of γ ray of 393 keV which is suitable for scanning. Large amounts (several millicuries) of ^{113m}In can be injected for high photon yield for better scans in shorter time without exceeding the safety levels of radiation dose. (BBB)

31616 EFFECTS OF pH AND URANYL IONS ON ACTION POTENTIAL GENERATION AND ACETYLCHOLINE SENSITIVITY OF SKELETAL MUSCLE. Sokoll, M. D.; Thesleff, S. (Univ. of Lund., Sweden). Eur. J. Pharmacol., 4: 71-6(Aug. 1968).

Over the pH range 9.0 to 5.2, only a pH below 6 affected action potential generation. The effects were principally an elevation of the depolarization level at which an action potential was triggered and a reduction in the rate of rise of the spike. The acetylcholine sensitivity of the muscle membrane was progressively reduced below pH 6.5 and at pH 5.2 it was only 10% of its value at pH 7. The effects of pH alteration were maximal within 60 sec and were completely reversible. Uranyl ions (0.2 to 0.4 mM) increased the threshold for action potential generation and depressed the rate of rise of the spike. At a concentration of 0.2 mM the sensitivity of the membrane to acetylcholine was reduced to about 15% of the control level. The similar effect of pH alteration on action potential generation and acetylcholine sensitivity suggests that the membrane structures responsible for these two processes have a similar pK value. The finding that uranyl ions depressed both mechanisms indicates that these membrane structures are phosphate-containing macromolecules. (auth)

31617 COMPARISON OF THE DISTRIBUTION OF DEMETHYLCHLORTETRACYCLINE AND RADIOCALCIUM IN WHOLE-BODY SECTIONS OF TUMOR-BEARING MICE. Blomquist, Lars; Hanngren, Ake (Kungliga Veterinaerhoegskolan, Stockholm). Acta Med. Scand., 184: 13-18(1968).

The distribution pattern of ^{45}Ca and a tetracycline compound was compared in tumor-bearing mice by autoradiography and fluorescence technique, applied to whole body sections. Mice bearing a mammary carcinoma induced by polyoma virus and transplanted through several generations were given ^{45}Ca in a dose of 750 μCi/Kg. Other mice received 100 mg/Kg of body weight of demethylchlortetracycline (DMCTC). High and persisting accumulations of both compounds were found only in calcified organs such as bone, teeth, and tracheal cartilage. Though no gross calcification was present in the tumor, as judged from the von Kossa-stained sections, ^{45}Ca was concentrated in the cellular tumor parts at 1 and 5 hr after injection with a decay at 12 hr. Only weak radioactivity was seen in totally necrotic, structureless areas. DMCTC-induced fluorescence seen only in the cellular areas was neither more intense nor retained for a longer time than in many other soft tissues. DMCTC and ^{45}Ca given simultaneously interfered with each other's distribution and were, for example, highly accumulated in the lungs and red pulp of the spleen, which suggests an intravascular complex formation. The risk of intravascular precipitate formation so as to cause multiple occlusions in the capillaries of patients given Ca and tetracycline compounds simultaneously is mentioned. (BBB)

31618 IMPACT OF RADIOACTIVITY ON THE LIFE SCIENCES. Broda, Engelbert. pp 137-48 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968.

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

A brief history of the development of radioactive tracer techniques is presented. Advantages of radioanalytic methods in studies on the biochemistry of living systems are discussed. The uses of radioisotopes in studies on energy metabolism of animal cells in culture and determination of the final products of utilization of radioglucose in fermentation and respiration are described. The importance of the tracer method in research on respiration of bacterial spores, biosynthesis of steroids and porphyrins, and metabolic pathways in photosynthesis is discussed. Problems concerning the origin and evolution of living things are being studied with the aid of radioisotopes. (H.L.W.)

31619 THE EFFECT OF ENDOTOXIN AND THOROTRAST ON INDUCIBLE ENZYMES IN THE ISOLATED, PERFUSED RAT LIVER. Agarwal, M. K. (Columbia Univ., New York); Hoffman, W. W.; Rosen, F. Biochim. Biophys. Acta, 177: 250-8(Apr. 1, 1969).

Thorotrast lowers the activity of mouse-liver tryptophan oxygenase (L-tryptophan: H_2O_2 oxidoreductase) when the adrenocortical response to these noxious stimuli induces an increase in tyrosine-α-ketoglutarate transaminase (L-tyrosine: 2-oxoglutarate aminotransferase) activity. The manner in which ThO_2 influences tryptophan-oxygenase activity in liver was studied in rats. The effect of endotoxin and Thorotrast, singly and in combination with hydrocortisone, on tryptophan oxygenase and tyrosine transaminase was determined in intact rats and in the isolated, perfused rat liver. Endotoxin and Thorotrast both lowered tryptophan-oxygenase activity, and prevented hydrocortisone induction of this enzyme in the isolated perfused rat liver. In contrast to their inhibitory effect on tryptophan oxygenase, endotoxin and Thorotrast neither lowered tyrosine-transaminase activity in the perfused rat liver nor altered the hydrocortisone induction of this enzyme. These effects are compatible with results obtained after administration in vivo of these agents to intact rats. Partial purification of tryptophan oxygenase from livers of treated rats indicated the presence of some inhibitory substance. Thorotrast is localized in Kupffer cells, so that the reticuloendothelial system must control enzyme induction in rat liver. (BBB)

31620 THE ACCUMULATION OF ^{89}Sr AND ^{45}Ca BY AN AQUATIC OLIGOCHAETE. Whitten, Bert K. (Fitzsimons General Hospital, Denver); Goodnight, Clarence J. Physiol. Zool., 40: 371-85(Oct. 1967).

Strontium-89 and ^{45}Ca accumulation and retention were studied in tubificid worms (Limnodrilus hoffmeisteri and L. udekemianus). The worms were placed in solutions containing 10-μCi/l concentrations of the radionuclides. Concentration factors for ^{89}Sr and ^{45}Ca were determined and were found to be dependent on the Ca concentration of the medium. A nearly linear reduction in the accumulation of the radioactive ions with an increase in the stable Ca ion concentrations of the medium was observed over the range of concentrations investigated. The discrimination which occurred between Sr and Ca was also affected by the stable Ca ion concentration of the medium, and a decrease in the discrimination against Sr relative to Ca was found with an increase in the Ca concentration of the medium. Histological studies which utilized radioautography demonstrated that the radiostrontium and radiocalcium were absorbed into the tissues of tubificid worms. The heavy accumulation of ^{45}Ca and ^{89}Sr in the ampulla region of the nephridia suggested that this region which is associated with blood vessels is a site for reabsorption of these ions. (BBB)

31621 PATTERNS OF PROTEIN SYNTHESIS IN THE HeLa CANCER CELL. Kolodny, Gerald M. (Harvard Medical School, Boston, Massachusetts Inst. of Tech., Cambridge). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 746-55(Apr. 1969).

Variations in radiosensitivity occur during the cell cycle. In order to better understand the reasons for these variations, protein synthesis during the cell cycle has been studied. Proteins synthesized in one stage of the cell cycle have been labeled with one isotope and those proteins synthesized during other stages of the cell cycle labeled with a second isotope. The proteins so labeled were co-electrophoresed on polyacrylamide gels. The radioactivity distributions on the gels were analyzed and showed significant differences in the distributions of the two isotopes. Such differences indicate differences in the kinds of and/or rates of synthesis of proteins as the cell goes through the cell cycle. No definite correlation can yet be made between specific proteins or protein synthetic patterns and specific cell cycle changes in

radiosensitivity. However, the fact that changes in the p erns of protein synthesis are here shown to exist suggests th . further study of patterns of protein synthesis may lead to basic mechanisms of radiosensitivity. (auth)

31622 THE EXCRETION OF ^{131}I IN MILK AFTER RADIOISOTOPE RENOGRAPHY. Hengst, Wolfgang (Medizinische Klinik des Krankenhauses Nordwest, Frankfurt am Main). Z. Geburtsh. Gynaekol., 166: 284-90(Feb. 1967). (In German).

The excretion of ^{131}I in the milk of 30 post partum women was measured after radioisotope renography with ^{131}I-labeled iodohippuric acid and chloriodopropylinulin. Renography was performed on the day of parturition or within 1 or 2 days. The ^{131}I was measured in the milk obtained on the day of renography, and on the day 1 and 3 afterward. In the first 2 days after administration of the ^{131}I compounds 0.01 to 2% of the administered dose was found in the milk samples. No explanation for the range of ^{131}I excretion values measured was found. It was estimated on the basis of a 50% uptake of ^{131}I by a neonatal thyroid gland of 5 g wt that uptake of 1 μCi of ^{131}I would result in a thyroidal β irradiation dose of 10 R. It was concluded that to avoid any irradiation effect on the child it would be advisable not to feed the breast milk on the day of ^{131}I renography and the first day afterward. (BBB)

31623 ON THE CLEARANCE OF THOROTRAST, A DEXTRIN-STABILIZED COLLOID. Mueller, Thomas (Finseninstitutet, Copenhagen). Acta Pharm. Toxicol., 26: 491-500(1968).

After intravenous injection in rabbits of 3 to 4 ml/Kg of Thorotrast (25% vol/vol ThO_2, stabilized with 25% tapioca dextrin) a blood concentration of about 14 mg Th/ml was obtained. The elimination of Th from blood followed two first-order processes: a slow phase with a half-life of 6 to 22 hr, followed suddenly by a fast rate of disappearance with a half-life of 1 to 2½ hr. The duration of the slow phase was about 10 to 30 min after 1 ml/Kg of Thorotrast, increasing to 120 min after 3 ml/Kg. During this first phase, the elimination of ^{198}Au and ^{131}I-serum albumin of particle sizes of the same order of magnitude as ThO_2 was somewhat delayed, but not completely abolished. More than 90% of the dextrin injected with Thorotrast disappeared from the blood within 30 min, and much was retained in the liver in an amount not corresponding to the amount of ThO_2. Thorotrast injected into the mesenteric vein was not phagocytized during the first passage through the liver. (BBB)

31624 DISTRIBUTION OF ^{45}Ca AND OF ^{89}Sr IN THE MITOCHONDRIA AND OTHER CELLULAR STRUCTURES OF THE RAT LIVER IN VIVO. Carafoli, E. (Univ., Modena, Italy). Sperimentale, 117: 19-30(Jan.-Feb. 1967). (In Italian).

The incorporation of radiocalcium and radiostrontium into the subcellular fractions of rat liver was studied. It was found that, immediately after the injection of the isotopes, most of the ^{45}Ca and ^{89}Sr in the liver cell was associated with subcellular structures. Only negligible amounts of radioactivity were found in the soluble hyaloplasm. More than 50% of the total ^{45}Ca in the liver cell was associated with the mitochondrial fraction. The same results were obtained for ^{89}Sr. Mitochondria were the only subcellular structures capable of concentrating the isotopes with respect to the whole homogenate. The sp activity of ^{45}Ca after its injection was far greater in mitochrondria than in microsomes. The distribution of injected ^{89}Sr among subcellular liver fractions varied with time. Immediately after injection, mitochondria contained about 60% of the total radioactivity of the liver cell, and only small amounts were found in the endoplasmic reticulum and in the soluble supernatant. After 60 min, mitochondria had lost a large part of their ^{89}Sr, while the concentration of the isotope in the endoplasmic reticulum and in the soluble hyaloplasm increased considerably. The results are consistent with the view that mitochondria play a predominant role in the regulation of the concentration and of the location of Ca in the liver cell of the intact animal. They also suggested an important role of mitochondria and endoplasmic reticulum in the deposition of Sr in animal tissues. (BBB)

31625 RADIOACTIVE MONITORING OF DEGRANULATING MAST CELLS. Katz, Harry I.; Fusaro, Ramon M.; Smith, Q. T. (Univ. of Minnesota, Minneapolis). Acta Dermato-Venereol., 49: 125-7(1969).

A new radioisotope technique is described for monitoring alterations occurring in peritoneal mast cells by determination of the release of ^{35}S-labeled sulfated acid mucopolysaccharides from mast cells after their incubation with mast cell degranulating substances (Compound 48/80 and distilled water). Forty μCi of ^{35}S-sulfate (less than 0.1 mg total sulfate) in 0.2 ml of saline was given mice by intramuscular injection. At 48 hr after isotope injection, the animals were exsanguinated and injected with the degranulating agent. The radioactivity of the acid mucopolysaccharide then isolated from the peritoneal wash of the mice which received distilled water (21.6 cpm/ml) and 0.2 mg Compound 48/80 (23.4 cpm/ml) was significantly greater than that from the Ringer-Barron (control) solution alone (7.0 cpm/ml). The amount of ^{35}S-labeled sulfated acid mucopolysaccharide isolated from the peritoneal wash of animals given 1.0 mg Compound 48/80 (10.9 cpm/ml) also differed from the Ringer-Barron controls; however, the results were considerably lower than those obtained with the lesser amount of Compound 48/80. (BBB)

31626 STUDIES ON THE RELATION OF BIOLOGICAL HALF-LIFE OF RADIOACTIVE SODIUM ^{24}Na, AND RADIOACTIVE POTASSIUM ^{42}K BETWEEN AGING IN MOUSE. Kamimura, Hideo (Nihon Univ., Tokyo). Nichidai Igaku Zasshi, 27: 1139-51 (Oct. 1968). (In Japanese).

The relation between the biological half-life of ^{24}Na and ^{42}K and aging was studied in mice. The biological half-life of ^{24}Na seemed to be gradually shortened with the age of mice from 4-weeks-old to 7-weeks-old, but it was constant after 8-weeks-old. The biological half-life of ^{42}K remained roughly constant from 4-weeks-old to 14-weeks-old, and tended to shorten after 14-weeks-old. (NSA of Japan)

31627 METABOLISM OF THE RADIOISOTOPE ^{65}Zn IN THE FRESHWATER MUSSEL ANODONTA CALIFORNIENSIS. Pauley, Gilbert B.; Nakatani, Roy E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Fish. Res. Board Can., 25: 2691-4(1968).

The metabolism of ^{65}Zn in the freshwater mussel, Anodonta californiensis, was studied. Uptake of ^{65}Zn (μCi/g) by various parts of the mussel in relation to time (days) and total tissue burdens of ^{65}Zn in the soft parts of the mussel in relation to time (days) were determined. High concentrations of ^{65}Zn in the gills and low concentrations in the adductor muscle were observed. Stable zinc concentrations were found to be highest in the palps, gills, and mantle. Autoradiographic studies revealed that the kidney contained ca five times as much ^{65}Zn as any other tissue. The absorption of ^{65}Zn into the tissues was believed to probably occur through the epithelium of the mantle and gills and through the wall of the digestive tract. The observations reported for this freshwater lamellibranch were in agreement with those reported for marine molluscs. (C.O.)

31628 TRANSLOCATION AND DISTRIBUTION OF ^{210}Pb AND ^{210}Po SUPPLIED TO TOBACCO PLANTS. Tso, T. C. (Dept. of Agriculture, Beltsville, Md.); Fisenne, Isabel. Radiat. Bot., 8: 457-62(Dec. 1968).

Lead-210 and polonium-210 were supplied to tobacco plants (Nicotiana tabacum L. cv. maryland catterton) from soil, stem, and leaf surface to study the patterns of translocation and distribution of these elements. Test plants took up ^{210}Po and ^{210}Pb from roots or stems and the elements were distributed to various tissues. Direct absorption of ^{210}Po is therefore considered a major source of ^{210}Po supply, in addition to that from ingrowth of ^{210}Pb in leaf tobacco. A higher concentration of ^{210}Pb accumulated in younger upper leaves than in older lower leaves, while a higher concentration of ^{210}Po accumulated in older lower leaves than in younger upper leaves. When the two elements were applied to the leaf surface, little translocation or redistribution of ^{210}Pb was found from one leaf area to other leaf areas, but a very small portion of ^{210}Po applied on younger upper leaves transferred to older lower leaves. ^{210}Po applied on older lower leaves, however, remained where placed. (auth) (UK)

31629 RADIONUCLIDE DEPOSITION AND ELIMINATION IN A DARKLING BEETLE. Hakonson, T. E.; Rickard, W. H. (Battelle Memorial Inst., Richland, Wash.). Northwest Sci., 43: 23-8(Feb. 1969).

The elimination rate (biological half-time) and gross patterns of body distribution of ^{134}Cs, ^{85}Sr, ^{65}Zn, and ^{22}Na in Eleodes hispilabris were determined. Samples of voluntary muscle, exoskeleton, and internal organs were taken four weeks after radioisotope administration to obtain information concerning the body distribution of ^{85}Sr and ^{134}Cs. The initial loss of ^{134}Cs was characterized by rapid elimination; 95% was eliminated during the first week. The T ½ was calculated at 1.0 days for beetles maintained at 32°C and at 1.5 days for beetles maintained at 23°C; this difference was attributed to the greater food intake of the beetles maintained at 32° (40% more food/day). The T ½ time of ^{85}Sr from beetles of the 32° and 23°C temperature regimes was 1.8 and 1.5 days, respectively. The T ½ time of the slow loss components was 11 and 12 days, respectively. The concentration of ^{85}Sr at the end of 28 days was higher in internal organs than in either muscle or exoskeleton. A two-component retention curve was apparent for ^{22}Na as well as ^{85}Sr. About 80% of the Na was lost the first week; only 5% remained after 37 days. Zinc-65 loss differed from the other radioisotopes in that three different elimination rates were discerned. About 50% of the ingested Zn

was lost during the rapid and intermediate elimination phases; after 27 days, about 20% remained in the beetles. It was suggested that the long retention of ^{65}Zn was associated with the black pigments of the exoskeleton. (C.O.)

31630 ^{137}Cs RETENTION BY CATTLE, SHEEP, AND SWINE. Twardock, A. R.; Crackel, W. C. (Univ. of Illinois, Urbana). Contract AT(11-1)-1339. Health Phys., 16: 315-23(Mar. 1969).

A whole-body counter was used to measure ^{137}Cs retention after oral and intravenous administration to cattle, and after intravenous administration to sheep and swine. Retention, by all three species, was described as a multi-component exponential function of time. After oral administration cattle excreted ^{137}Cs by a 3-component exponential pattern having half-lives ($T^1/_2$) of 0.6, 4.2, and 33 days accounting for fractions of 0.22, 0.41, and 0.37 of the dose, respectively. Retention parameters for intravenous administration were similar, except that a greater fraction of the dose was excreted by the short-term component and lesser fractions by the longer-term components. Excretion was slower in the case of a cow that was in late gestation. Excretion by calves was more rapid than by mature cattle. Sheep also excreted intravenously administered ^{137}Cs with a 3-component pattern, whereas the retention curve of pigs had only 2 components. Component half-lives for sheep were 1.1, 5.3, and 25.5 days, accounting for 0.26, 0.34, and 0.41 of the dose, respectively. Half-lives of the 2 components for pigs were 3.5 and 34.7 days, accounting for 0.18 and 0.82 of the dose. (auth)(UK)

31631 TWO STUDIES OF ACUTE INTERNAL EXPOSURE TO MAN INVOLVING CERIUM AND TANTALUM RADIOISOTOPES. Sill, Claude W.; Voelz, George L.; Olson, Dale G.; Anderson, Jesse I. (Health Services Lab., Idaho Falls, Idaho). Health Phys., 16: 325-32(Mar. 1969).

Actual exposures of humans to internal radioactive contamination provide the most valuable data in determining the behavior of these substances in man. Two recent exposures at the National Reactor Testing Station demonstrate the markedly different behavior that can result from inhalation of insoluble particulates. In one incident, an individual received a body burden of 36 μCi of ^{141}Ce, 27 μCi of ^{144}Ce and 13.5 μCi of $^{95}Zr-^{95}Nb$. Over 99.7% of his total body burden was eliminated in only 4 days, all of which was through the gastrointestinal tract, with a total dose of about 10.3 rems to the lower large intestine. In the other incident, an individual received a body burden of 30 μCi of ^{182}Ta and 150 μCi of ^{183}Ta. Approximately 93% of the activity was eliminated in 7 days, the elimination being entirely in the feces. The remaining activity decreased at a rate not statistically different the 115-day radiological half life of ^{182}Ta, resulting in a dose of 13 rems to the lungs. The actual biological elimination could be detected only on large samples of feces and amounted to less than 0.05%/day. The major contaminants were not detected in 24-hr urines in either incident. (auth)(UK)

31632 TRITIATED WATER IN THE MEASUREMENT OF MILK INTAKE AND TISSUE GROWTH OF RUMINANTS IN THE FIELD. Macfarlane, W. V.; Howard, B.; Siebert, B. D. (Univ. of Adelaide). Nature (London), 221: 578-9(Feb. 8, 1969).

Study of the metabolism of tritiated water in the young ruminant allows estimation of body solids content as well as an integrated measure of milk taken. The environmental adaptation of adults may also be compared, using water turnover as an integral of behavior and energy expenditure. In the studies described, using lambs, tritiated water was made up in 150 mM NaCl, 10 μCi/kg was injected intramuscularly, and a blood sample was drawn at the end of the appropriate equilibration period. Animals were then allowed to graze freely and a blood sample was taken at 7 to 15 days. At the same time another dose of tritiated water was injected to determine volume changes of body water and changes of solids content during growth. Specific activity was determined by scintillation counting. A relation between water turnover and milk intake was confirmed with lambs bottle fed from birth with artificial milk of known composition. Agreement of measured water intake from milk of known composition together with metabolic water, and tritium estimation, was high. The body solids as a fraction of body weight were estimated by subtracting the tritiated water space from the weight of the animals. Results are tabulated. Studies were also made with calves. The effects of environmental conditions, particularly humidity, were also examined. Measures of the efficiency of energy conversion could also be obtained. Advantages of this water metabolism method are outlined. (UK)

31633 RETARDATION OF CLOT RETRACTION AFTER INCUBATION OF PLATELETS WITH COLCHICINE AND HEAVY WATER. Shepro, D.; Belamarich, F. A.; Chao, F. C. (Univ. of Boston. Marine Biological Lab., Woods Hole, Mass.). Nature (London), 221: 563-5(Feb. 8, 1969).

In addition to the colchicine studies, suspended platelets were incubated in 0.9% saline made with different amounts of D_2O, and then recalcified with $CaCl_2$ to form a clot, the degree of clot retraction subsequently being measured. For each D_2O concentration a control was set up with H_2O. The results substantiated the role of microtubules-microfibres in platelets as part of the contractile system. Deuteration appeared to enhance polymerization of protein units and to favor stability in that state. With 80% D_2O clot retraction was delayed for 120 min (the length of the experiment). The retardation of clot retraction was almost completely reversed by working with PPP (platelet poor plasma). The results both for colchicine and D_2O may provide a working model for the sources of contractile proteins in platelets. (UK)

31634 FIXATION OF IONIC ^{45}Ca IN TISSUE FOR AUTORADIOGRAPHIC DETECTION. Halbhuber, K. J.; Geyer, G. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Histochem., 31: 222-3 (1968).

A method for ascertaining the localization of ^{45}Ca in tissue by autoradiography was described. Because of its weak binding by tissues and its relatively high water solubility, it has been difficult to measure tissue localization of ^{45}Ca by autoradiography. For this reason it has been necessary to avoid contact of tissue sections with water. In methods reported previously the ^{45}Ca was fixed in the tissue by precipitation as the oxalate before use of a photoemulsion. The ^{45}Ca oxalate was practically insoluble in water, xylol, or alcohol, so that the labeled tissue section could be handled in the usual way for autoradiography. The method described included freezing and substitution treatment of the ^{45}Ca section with an oxalate-ethyl alcohol solution, or freeze-drying of the tissue sections before embedding in paraffin. Both methods caused immediate immobilization of the ^{45}Ca phase without its deposition as oxalate. (BBB)

31635 HEMATOLOGICAL EFFECTS IN THE CHICK PRODUCED BY INTERNAL RADIATION WITH DIFFERENT ISOTOPES OF STRONTIUM. BIOCHEMICAL INTERRELATIONS OF CALCIUM AND STRONTIUM. Allen, William Sherrill. College Station, Tex., Texas A and M Univ., 1968. 106p.

Thesis.

Day old chicks were given four different levels of ^{85}Sr, ^{89}Sr, or ^{90}Sr by intramuscular injection. The peripheral blood was examined by making erythrocyte counts, differential counts and leucocyte counts. Hematocrit and hemoglobin determinations were run and relationships between hematocrit, hemoglobin and erythrocyte counts were calculated. The effect of replacing calcium with strontium on the ultrastructure of fibrin was investigated. At the end of four weeks all levels of either isotope gave reduced erythrocyte counts, hemoglobin content and hemotocrit values. The leucocyte counts initially (at one week after injection) increased, but normal levels were not reached. Differential counts are also reported. When calcium is replaced by strontium in the clotting process, there is a reduction in the width of the fibrin fiber and a higher degree of overall homogeneity is present. This was demonstrated by utilizing electron microscopy. The distribution patterns of strontium for four different plants were established. The rate of uptake of strontium and the degree of translocation of strontium were investigated, as well as the amounts taken up and the effects on the growth of plants when high levels of strontium are present in the culture solution. The distribution patterns as shown by autoradiographs are very similar to those reported for calcium. Strontium was shown to be rapidly taken in by the plant and also to be very mobile in actively growing plant tissue. The toxicity of high levels of strontium in the growth medium varies with different species of plants. (Disser. Abstr.)

31636 ISOLATION OF THE OUTER LAYER OF THE NUCLEAR ENVELOPE. COMPOSITION OF THE RNA. Smith, S. J.; Adams, H. R.; Smetana, K.; Busch, H. (Baylor Univ., Houston, Tex.). Exp. Cell Res., 55: 185-97(May 1969).

A new method is presented for the isolation of the outer layer of the nuclear envelope and its attached ribosomes. Nuclei isolated from rat livers by the method of Chauveau et al., were treated with 2.5% citric acid to separate the outer layer of the nuclear envelope from the remainder of the nucleus. Morphological evidence showed that the precipitate obtained by high speed centrifugation of the citric acid extract contained both membranes and ribosomes. Evidence that the RNA of the outer layer of the nuclear envelope is a mixture of ribosomal and other RNAs was obtained by kinetic studies, UV and ^{32}P nucleotide analyses, and the effects of actinomycin D. The kinetics of labeling of the 18S and 28S RNA of the outer layer of the nuclear envelope with orotic ^{14}C-2-acid were intermediate between those of cytoplasmic ribosomal RNA and nuclear RNA. Maximal labeling was found in 6 h for RNA of the nuclear envelope, 46 h for ribosomal RNA, and 40 min for nuclear RNA. The half-lives of the 18S and 28S RNA of the outer layer of the nuclear envelope were shorter than those of ribosomal

RNA and longer than those of nuclear RNA. Although the UV base compositions of nuclear RNA and RNA of the outerlayer of the nuclear envelope were similar the 18S RNA of the latter had a higher content of uridylic acid and a lower content of guanylic acid than nuclear 18S RNA. The 28S RNA of the nuclear envelope had a higher content of adenylic and uridylic acids and a lower content of cytidylic and guanylic acids than nuclear 28S RNA. The distribution of ^{32}P in the nucleotides of 18S RNA of the outer layer of the nuclear envelope was similar to that of nuclear 18S RNA. For the 28S RNA of the nuclear envelope, the differences were more marked. The 28S RNA of the nuclear envelope had a lower ^{32}P content in uridylic acid and a higher ^{32}P content in guanylic and cytidylic acids than nuclear 28S RNA. Actinomycin D inhibited the labeling of nuclear 18S and 28S RNA equally but in the outer layer of the nuclear envelope the labeling of 18S RNA was inhibited by more than 50% with no significant effect on labeling of the 28S RNA. (auth)

Radiation Effects

Refer also to abstracts 31368, 31685, 31878, 31906, 31936, 31942, 31950, 31964, 31965, and 32893.

31637 (AD-683308) GASTRIC MUCOSA AFTER IRRADIATION. I. EVIDENCE FOR NEURAL AND PERMEABILITY CHANGES AFFECTING ELECTRICAL POLARIZATION AT 4 HOUR AND 170 HOUR. Vaughan, Burton E.; Pessotti, Rita L. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 12, 1968. 18p. (USNRDL-TR-68-147). CFSTI.

Recent work has permitted separation of an intact mucosa from isolated stomach of irradiated rats, and these preparations show several important differences from previous studies. Four hours after irradiation, mucosas showed 30% elevation in transmural potential due to an inhibition of the normally tonic cholinergic excitation of this separated epithelium. Other factors which could directly alter the transmural electrical potential remained essentially constant; for example tissue permeability as determined by electrical conductance, and the sensitivity of the cholinergic effector system to acetylcholine. By contrast, mucosas 170 hours after irradiation showed no change in potential and a consistent increase in permeability (conductance) of about 17%. In addition, they showed much greater reactivity toward acetylcholine, compared to nonirradiated mucosas. The changes observed after 170 hours are attributable to a decreased tissue thickness and they adequately explain earlier findings, showing seventh day inhibition of electrical activity in isolated, irradiated whole stomach. (auth) (USGRDR)

31638 (AD-683664) ASSESSMENT OF RADIATION DAMAGE TO THE HEMATOPOIETIC CELLS OF MICE-DEPENDENCE OF Do ON THE SIZE OF ENDOGENOUS SPLEEN NODULES. Ainsworth, Earl J.; Larsen, Rex M.; McKee, Adam E. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 31, 1968. 21p. (USNRDL-TR-69-2). CFSTI.

The colony-forming unit (CFU) exhibits many properties of the hematopoietic stem cell, and CFU methodology has been extensively used in many laboratories to assess radiation damage to the hematopoietic system of mice. The radiation responses of CFU's may be measured by either the endogenous or the transplantation method, and with either method, the number of spleen nodules decreases exponentially with increasing radiation exposure. (auth) (USGRDR)

31639 (CONF-670649-6) ^{65}Zn AS SOURCE OF INTERNAL IRRADIATION: ITS EFFECT ON THE CIRCULATING BLOOD. Luque Cabrera, J.; Galarza, A. M.; Santos Ruiz, A. (Madrid Univ. (Spain). Departamento de Bioquimica). [1967]. 10p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The effects on the circulating iron after intraperitoneal injection of fractional and single doses of ^{65}Zn in dogs are reported. Immediately after irradiation ^{65}Zn produces normocytic and hypochromic anemia. The hematocrit and the number of circulating erythrocytes decreased as well as the hemoglobin and the color index. The corpuscular volume was not altered. The initial anemia could be produced by a destruction of circulating cells or by an inhibition in the formation of hemoglobin precursors. The hemoglobin appears to be directly affected. The circulating blood plasma is particularly altered. A sharp increase of the serum iron was observed. Parallel experiments in rats suggested that this increase was caused by the hemoglobin iron entering the plasma. The initial anemia is probably due to the destruction of erythrocytes with a transfer of their hemoglobin to the plasma. (C.O.)

31640 (COO-1602-14) PROPOSED MECHANISM FOR THE DIFFERENTIAL RADIOSENSITIVITY OF THE IMMATURE RAT TESTIS. Ellis, Legrande C.; Baptista, Mario H. (Utah State Univ., Logan. Dept. of Zoology). [1969]. 49p. (CONF-690501-3). Dep. CFSTI.

From 9th Annual Hanford Symposium on Radiation Biology of the Fetal and Juvenile Mammal, Richland, Wash.

Lipid peroxidation by rat testicular tissue was studied as it related to androgen synthesis, aging, x-irradiation and the action of some antioxidants and radioprotective agents on the testis. The peroxidation of lipids increased with age and was depressed by hypophysectomy. Ascorbic acid, mercaptoethanol, hydrogen peroxide, NADPH, glucose-6-phosphate, oxygen, D-α-tochoperol, melatonin, and some prostaglandins were investigated with respect to their action on steroid biotransformations and lipid peroxidation. The differences between the action of the above compounds on lipid peroxidation and steroid biotransformations by adrenal and testicular tissue were pointed out. Similarities in the pathways for the synthesis of lipid peroxides and steroid biotransformations were pointed out. A mechanism was proposed to explain the action of the antioxidants and radioprotective agents on androgen synthesis and lipid peroxidation. The apparent role of lipid peroxidation in malonaldehyde production, prostaglandin synthesis and sulfur metabolism was indicated. Similarly, an action of prostaglandins on androgen synthesis and lipid peroxidation was demonstrated. The action of antioxidants and radioprotective compounds on the testis were discussed as they related to cellular activity within the male gonad as their actions related to aging and x-irradiation damage. Mechanisms were proposed to explain the differential in sensitivity that exists for cell types within the testis to radiation damage based on free radicals, sulfur metabolism, glutathione reductase, and antioxidants. (auth)

31641 (NYO-3445-18) STUDIES ON THE MECHANISM(S) OF INCREASED EXTRACELLULAR EPIDERMAL DNase I ACTIVITY AFTER β-IRRADIATION INJURY OR OTHER SKIN TRAUMA. Fifth Year Progress Report, April 15, 1968-April 15, 1969. Tabachnick, Joseph (Albert Einstein Medical Center, Philadelphia, Pa. Lab. of Experimental Dermatology). 26p. Dep. CFSTI.

Preliminary data were extended regarding increases in activity of DNase I in saline washings from the skin surface after 3000 rep β irradiation of guinea pig skin. Peak increases (from near 0) to 4 to 10 μg/ml of DNase I occurred between the 10th to 17th day postirradiation. The early increases due to skin trauma are difficult to evaluate since close clipping of hair, a prerequisite for affixing plastic cups, also stimulates a rapid (24 hr) increase in DNase I. This phenomenon may have survival value by protecting the animal against infectious nucleic acid. The heightened activity may be due to increased activators, loss of inhibitors, increased diffusion into epidermis of free or inhibitor-bound DNase I via altered blood vessels, or increased synthesis of enzyme protein. Evidence to date suggests the latter as most likely. Histologic evidence limits the origin of extracellular DNase I to the blood or an activated epidermis. Xylene produced a hyperemia in 30 sec and increased vascular permeability, but this did not hasten the initial increase (12 to 24 hrs). Sephadex G-100 chromatography indicates that epidermal DNase I has a M.W. of ca. 30,000. (auth)

31642 THE SIGNIFICANCE OF THE EFFECT OF STARVATION FOR THE ESTIMATION OF CHANGES OF LIPID METABOLISM FOLLOWING TOTAL BODY X-IRRADIATION OF RATS WITH HIGH DOSES. Winkler, L.; Grossklaus, R.; Hertel, R.; Goetze, E. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 21: 781-90(1968). (In German).

Starving rats were seen to change the fatty acid pattern of liver triglycerides in the sense of increasing linoleic acid and decreasing oleic and palmitic acid content. X-irradiated and sham-irradiated animals did not show this re-orientation. Irradiation produced merely an indication of an increase in linoleic acid. The absolute amount of free linoleic acid in plasma in irradiated animals was significantly lower than in starved animals, or after 24 hrs of starvation alone. The total amount of free fatty acids in plasma was increased by sham-irradiation to a degree that no difference was observed when compared with starvation or irradiation. However, this change remained without influence on the fatty acid pattern. (auth)

31643 RADIATION PROTECTION OF GLYCINE AND GLYCYLGLYCINE. Wheeler, Owen H.; Santos, Milagros; Ribot, Rosa Amparo; Ramos, Myriam (Univ. of Puerto Rico, Mayaguez). Radiat. Res., 36: 601-9(Dec. 1968).

The protective action of a series of organic sulfur compounds and amino acids against deactivation by γ radiation was investigated by using glycine and glycylglycine as substrates. A linear relationship was shown to exist between the reciprocal of the G_{-m} value for the substrate in the presence of the protecting agent, and

the concentration of this protecting agent in the solution. The protecting activity of the agents, expressed as the ratio of the rate constants for the reaction of radicals with the protecting agent and the substrate, was determined. (auth)

31644 THE INFLUENCES OF IRRADIATION ON LEUKOCYTE ALKALINE PHOSPHATASE. 2. CHANGES BY FRACTIONAL IRRADIATIONS OF X-RAY. Kobayashi, Hiroo (Jikei Univ., Tokyo). Tokyo Jikeikai Ika Daigaku Zasshi, 82: 635-45(Sept. 1967). (In Japanese).

To find out influences of frequent irradiations on a living body, total doses of 300R-3R of x ray were administered to rabbits divided in 10 exposures. Change of activity of the leukocyte alkaline phosphatase was investigated as follows. The number of both leukocytes and lymphocytes was decreased in the irradiated group of 300R total dose, but change in proportion to the irradiation dose was not shown in each group with total dose of less than 100R. The number of pseudoeosinocytes increased only in the 100R-irradiated group, but noteworthy changes were not observed in the other groups. Alkaline phosphatase index increased in each group with 300R, 100R, 25R, and 15R total doses, but change did not depend on the irradiation dose, and noteworthy changes were not observed in 50R and 3R-irradiated groups. The number of extremely positive cells to leukocyte alkaline phosphatase increased in each group of more than 12R irradiation, and especially in the 100R irradiated group. But change in proportion to the irradiated dose was not observed. In the 300R-irradiated group, the number of leukocytes, number of lymphocytes, alkaline phosphatase index, and number of strongly positive cells to leukocyte alkaline phosphatase all showed conspicuous changes, but in groups of less than 100R irradiation the above items did not show changes in proportion to the radiation doses that were observed in a single irradiation. This was due to the fact that in fractional irradiation, a complicated relation exists between influences of irradiation and their apocatastatic mechanism. (NSA of Japan)

31645 THE INFLUENCES OF IRRADIATION OF LEUKOCYTE ALKALINE PHOSPHATASE. 1. CHANGES WITH ONE GENERAL IRRADIATION OF X-RAYS. Kobayashi, Hiroo (Jikei Univ., Tokyo). Tokyo Jikeikai Ika Daigaku Zasshi, 82: 621-34(Sept. 1967). (In Japanese).

In order to investigate the effects of low dose irradiation on a living body, rabbits were irradiated with 100R-3R of x ray in one dose to the whole body, and changes in leukocyte alkaline phosphatase activity were studied. The number of leukocytes and pseudoeosinocytes both showed an increase in each irradiated group a short time after irradiation, especially the number of pseudoeosinocytes which increased in proportion to the dose. The number of lymphocytes decreased greatly in each group of 100R and 50R a short time after irradiation, but only slight changes were observed in the other groups. As for the alkaline phosphatase index, a slight increase was observed in each group of 100R, 25R, and 12R until two days after irradiation, though noteworthy changes were not observed in the other groups. The number of extremely positive cells for leukocyte alkaline phosphatase in each group increased in proportion to the dose a short time after irradiation, and showed the most sensitive reaction in these examinations especially in the 100R and 50R groups. As the number of extremely positive cells for leukocyte alkaline phosphatase examined here showed the most sensitive changes and increases in proportion to the dose in a short time, it seems to be a valuable way to determine the effects of radiation on a living body. (NSA of Japan)

31646 X-IRRADIATION OF RIBONUCLEASE AND TRYPSIN. EFFECT OF COPPER IONS, IRON IONS, AND DISODIUM-EDTA. Holmby, Bjoerg; Langeland, Tor. (Oslo Univ.). Phys. Norv., 3: 63-5(1968).

Experiments are reported on the X-ray inactivation of dry ribonuclease and trypsin, in pure form and treated with Fe^{++}, Cu^{++} and Na_2-EDTA. Under the conditions used iron and copper ions had only a small effect on the radiosensitivity. Ribonuclease was protected by Na_2EDTA against x rays, but trypsin was not affected. (auth) (Norway)

31647 BIOLOGICAL IMPORTANCE OF UV-INDUCED DNA-PROTEIN CROSS-LINKING IN VIVO AND ITS PROBABLE CHEMICAL MECHANISM. Smith, Kendric C. (Stanford Univ., Palo Alto, Calif.). Photochem. Photobiol., 7: 651-60(June 1968).

The increased sensitivity of Escherichia coli to killing by uv while frozen and the changes in sensitivity as a function of temperature during irradiation were correlated with the increased production of DNA-protein cross-links and were shown to be related to thymine dimer production. Results are reported from studies on the kinetics of the photochemical addition of ^{35}S-cysteine to various polynucleotides and to DNA. Selected rate constants for addition were determined. The rate constants for native and heat-denaturated DNA were accounted for by the summation of the rate constants for the appropriate polynucleotides. The addition of cysteine to RNA showed a biphasic response probably related to the amount of single-stranded regions present. Preliminary results indicate that tyrosine and serine also add photochemically to DNA. (auth)

31648 PHOTOCHEMISTRY OF TOBACCO MOSAIC VIRUS RNA. Evans, Neil A.; McLaren, A. D. (Univ. of California, Berkeley). Photochem. Photobiol., 7: 661-4(June 1968).

The photochemistry of tobacco mosaic virus RNA (TMV-RNA) is discussed in relation to the biologically defined lesions of its uv-inactivation, lethal damage, and photoreactivable damage. In order to explore mechanisms of photoreactivation of these phenomena, we have investigated the effect of HCN on the quantum yield for uv inactivation of TMV-RNA, on the per cent photoreactivation of irradiated TMV-RNA, and on the photoproducts of the model, polyuridylic acid (poly U). The ratio of the quantum yield for inactivation of TMV-RNA under nonphotoreactivating conditions in the presence of HCN to that in the absence of HCN, 1.5, may be compared with the ratio of the initial rates of reaction of uracil residues in poly U under the same conditions, 1.6. This similarity of ratios suggests that one or more of the mechanisms of uv inactivation of TMV-RNA are similar in nature to the mechanisms for reaction of uracil residues in poly U, i.e., hydration and dimerization. The photohydration in poly U, as measured by the heat reversal of hydrated residues to uracil residues, is reduced to a negligible quantity by HCN, whereas the rate of dimerization, as measured by the appearance of dimer-containing oligonucleotides following enzymatic hydrolysis of irradiated poly U, is reduced to half by HCN. The observed drop in per cent photoreactivation in the presence of HCN was 60 per cent of that in its absence, indicating that either the hydrate is not a photoreactivable lesion or there are at least two photoreactivable lesions. (auth)

31649 EFFECT OF PHYTOHEMAGGLUTININ ON HUMAN BLOOD LYMPHOCYTES IRRADIATED IN VITRO. Cirkovic, Dimitrije (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 137: 74-7(Jan. 1969).

Effects of phytohemagglutinin on in vitro irradiated human lymphocytes were studied. Nucleic acid content and ^{14}C-thymidine incorporation into DNA served as the parameters of lymphocyte transformations. Doses of 25 to 3000 R were used. A dose of 25 R had no effect on DNA synthesis in PHA treated lymphocytes while 500 R reduced thymidine incorporation by 60 per cent as compared with the controls. Further increase of the dose did not markedly decrease the incorporation rate. This indicates that resistant cells synthetize DNA. PHA treated and nontreated lymphocyte suspensions were irradiated with doses of 500, 1500 and 3000 R, and it was found that PHA treated cells have a higher nucleic acid content at all doses which indicates that PHA had protected the lymphocytes from irradiation, and that they were capable to respond to stimulation. (auth)

31650 FORMALDEHYDE AS A RADIOPROTECTOR AGENT. Gampel, Zulema; Pieber, Maria; Toha C., Jose (Univ. de Chile, Santiago). Arch. Biol. Med. Exp., 4: 291-2(July 31, 1967).

The radioprotective action of formaldehyde on aqueous DNA solutions is described. To 6 mg of highly polymerized salmon sperm DNA in 100 ml water, formaldehyde was added to a final concentration of 2% (w/v). The solutions were irradiated with γ rays from a ^{137}Cs source (200 rad/min), the maximum dose being 48×10^4 rad. It was found on the basis of optical density measurements made at 260 mμ that DNA irradiated in the presence of formaldehyde solution is strongly protected against radiation damage. This occurred even for solutions which had been submitted to heating and rapid cooling before the irradiation (denaturated). The percentage of hydrolysis and destruction of native and denaturated irradiated DNA solutions indicated that the destruction of DNA in solutions irradiated in the presence of formaldehyde is considerably smaller than that which occurs in solutions without formaldehyde. For example, irradiation of native DNA with a total dose of 24×10^4 rad gave an O. D. at 260 μ of 0.081 for nonprotected DNA, and 1.522 for protected DNA. The second value is practically the same as the value before irradiation. In experiments with denaturated DNA plus formaldehyde, a certain degree of hydrolysis of DNA also occurred which is probably due to the reaction with formaldehyde, since the fraction hydrolyzed remains constant and is independent of the irradiation dose. The absorbency ratios (250/260, 270/260, 280/260, and 290/260) did not change during irradiation. The protective action of formaldehyde is probably not related to a chemical reaction with the NH_2 groups of the bases and is independent of the secondary structure of DNA. The mechanism of radioprotection may include the scavenger action of formaldehyde on the free radicals induced by radiolysis of water. (BBB)

31651 CHANGES IN THE ULTRAVIOLET FLUORESCENCE INTENSITY OF IRRADIATED CELLS UNDER CONDITIONS OF A

TOTAL ABSORPTION OF EXCITING IRRADIATION. Brumberg, I. E.; Merkle, K. (Central Roentgen-Radiological Inst., Leningrad). Tsitologiya, 11: 509-11(Apr. 1969). (In Russian).

A simple method has been elaborated for the study of the uv fluorescence intensity, the latter being determined in a thick layer of cells. Using this method, the intensity of uv fluorescence of the irradiated cells of the ascite Ehrlich tumor and their descendants were shown to depend on the dose of irradiation. (auth)

31652 ON THE STIMULATION OF DNA SYNTHESIS UNDER X-IRRADIATION OF HeLa CELLS. Paribok, V. P.; Semenova, E. G. (Inst. of Cytology, Leningrad). Tsitologiya, 11: 469-75 (Apr. 1969). (In Russian).

X-irradiation of asynchronous HeLa cell cultures with 5000 R appeared to have a dual influence on the DNA synthesis of the cells: on the one hand, it depressed ^{3}H-thymidine incorporation into cells at S-phase; on the other hand, it stimulated this incorporation in some portion of cells ($^1/_2$-$^1/_4$) at phases G_1 and G_2. The former effect prevailed when the dose of x-rays increased up to 10,000 R and that of γ-rays (^{137}Cs) up 100,000 rad. The irradiation with 5000 R of the synchronous cells in the G_1-phase did not provoke a stimulation of DNA synthesis. Thus, in HeLa cells the repair synthesis is absent at least in G_1-phase. The stimulation of DNA synthesis in the irradiated asynchronous culture may be explained by a prolongation of S-phase or by a return from G_2 to S-phase, as well as by a repair synthesis occurring in G_2-phase. The treatment of the asynchronous HeLa culture by 5-BUdR stimulated the incorporation of ^{3}H-thymidine at non-synthetic phases of the cycle but did not affect a stimulation of the ^{3}H-thymidine incorporation after irradiation with 5000 R. (auth)

31653 ULTRAVIOLET LIGHT IRRADIATION AND FAT METABOLISM IN GUINEA PIGS SUBJECTED TO EXOGENOUS CHOLESTEROL FEEDING. Simko, V.; Ondreicka, R.; Bobek, P.; Babala, J. (Research Inst. of Human Nutrition, Bratislava). J. Atheroscler. Res., 8: 935-44(Nov.-Dec. 1968).

The effect of uv irradiation on guinea pigs fed a high-cholesterol, high-saturated fat diet, was studied. Male albino guinea pigs were fed a natural diet containing 14% fat (largely saturated butter fat) with about 35 mg natural cholesterol per 100 g food. Crystalline cholesterol was added at a rate of 250 mg/100 g food. The irradiated group were exposed for 6 days a week to a quartz lamp (Chirana type S 5001, 500 W, 70 VA), at a distance of 70 cm. After a 5-day period of small initial doses the daily duration of irradiation was increased to 15 min. Such daily uv irradiation caused no differences in skin sterol levels, but the amount of cholesterol in the liver, lungs, adrenals, and intestine was significantly increased in the irradiated animals. Irradiation was associated with a decrease in epididymal fat weight and diminution of esterified fatty acids in this tissue and in the liver; the level of this fraction in serum was higher. Cholesteryl esters in epididymal fat showed a shift from monoenes to saturated fatty acids. Microscopic examination of the aorta and myocardium revealed more severe atherosclerotic changes in irradiated animals. It is concluded that the effect of uv irradiation may be dependent on the dietary fat composition, the extent of exogenous cholesterol intake, and rate of endogenous sterol synthesis. (BBB)

31654 STUDIES OF THE METABOLISM OF THE EPIDERMAL CELLS IN ACANTHOSIS. II. COMPARATIVE ENZYMOBIOCHEMICAL STUDIES IN ACANTHOSIS. Rassner, G. (Univ., Munich). Arch. Klin. Exp. Dermatol., 233: 430-8(1969). (In German).

Enzymatic activities measured in acanthotic epidermis of guinea pigs x irradiated with a single dose of 1000 R were compared with enzyme activities found in acanthosis produced by vaseline or testosterone, and psoriasis vulgaris. The enzymatic pattern found in x-ray acanthosis was characterized by pronounced decreases in activity of almost all enzymes studied, while the enzymatic activities were increased in the other acanthoses. At the end of two weeks after x irradiation the enzymatic activities of pyruvate kinase, lactic dehydrogenase, isocitrate dehydrogenase, malate dehydrogenase, glucose-6-phosphate dehydrogenase, and glycerol-1-phosphate dehydrogenase were decreased by 62, 26, 20, 22, 75, 81, and 55%, respectively. (BBB)

31655 STUDIES OF THE METABOLISM OF THE EPIDERMAL CELLS IN ACANTHOSIS. I. X-RAY ACANTHOSIS. Rassner, G. (Univ., Munich). Arch. Klin. Exp. Dermatol., 233: 425-9(1969). (In German).

Enzymatic activities were measured in guinea pig skin sections following a single x irradiation with a dose of 1000 R. Within 7 days of irradiation the activities of glyceraldehyde-3-phosphate dehydrogenase (GAPDH), pyruvate kinase (PK), lactate dehydrogenase (LDH), malate dehydrogenase (MDH), glucose-6-phosphate dehydrogenase (G-6-PDH), and creatine kinase (CK) were reduced by ~30, 65, 45, 40, 80, and 60%, respectively. By the end of 2 weeks the activities of these enzymes had increased more toward normal values. However, the activity of PK still was decreased by 57%, and the activities of GAPDH, LDH, MDH, G-6-PDH, and CK were decreased by ~8, 26, 22, 75, and 74%, respectively. The activity of glycerol-1-phosphate dehydrogenase was decreased by 79%, and that of malate enzyme was increased by 42%. Histologically, there was slight contraction of the epidermis and the acanthosis factor was 0.95 6 days after irradiation. By the end of 2 weeks after irradiation the acanthosis factor was 1.5 and the spinosum and granulosum layers were extended and hyperkeratosed, but there was no evidence of cytological changes. (BBB)

31656 INACTIVATION OF BACTERIOPHAGE, DNA, AND RIBONUCLEASE BY THERMAL HYDROGEN ATOMS. Jung, Horst; Kuerzinger, Klaus (Kernforschungszentrum, Karlsruhe, Ger.). Radiat. Res., 36: 369-83(Dec. 1968).

T1 phage, BU-T1 phage, infectious DNA extracted from phage ϕX 174, and chromatographically purified ribonuclease were exposed to thermal hydrogen atoms, and the loss of plaque-forming ability, infectivity, or enzymatic activity was determined after various exposure times. Atomic hydrogen was generated by two different methods; by a high-frequency discharge in hydrogen gas and by irradiating a foil of polyethyleneterephthalate with 2-MeV protons. With increasing exposure time the surviving fraction of all objects tested approaches a constant level. After subtracting this constant indestructible fraction in either system, all objects were inactivated according to exponential curves. Furthermore, no BU sensitization was found to occur in BU-T1 phage exposed to atomic hydrogen, whereas γ irradiation of samples from the same batches revealed a BU effect of a factor of 2.2. These experiments demonstrate hydrogen atoms to be efficient in causing biological damage. Consequently the terminology of direct and indirect radiation effect may have to be redefined. (auth)

31657 EFFECT OF IONIZING RADIATION ON THE LEUKOCYTE ALKALINE PHOSPHATASE. Kobayashi, Hiroo (Jikei Univ., Tokyo). Jikeikai Med. J., 15: 125-7(Jan. 1968).

The leukocyte alkaline phosphatase (L-AP) of rabbits was studied following acute x irradiation, repeated x irradiation, and acute thermal neutron irradiation. The L-AP Index (API) and the number of high L-AP activity cells (H-A) were compared to the number of leukocytes, neutrophils, and lymphocytes before and after irradiation. In the case of acute x irradiation, the number of leukocytes and pseudoeosinophils increased and the API increased for a short period of time, whereas the number of lymphocytes decreased. On the other hand, the increase in the number of H-A was remarkable. Regarding the mechanism of these changes, it was considered that the radiation acted as a stress on the body rather than directly on the bone marrow because the phenomena observed were transient and occurred shortly after irradiation. In the case of repeated x irradiation, similar changes to those observed in acute radiation exposures were observed in the 300 R irradiated group; in the lower level radiation groups, no remarkable changes were observed. These differences in results were attributed to intricate involvement of recovery mechanisms that are related to radiation time. In the thermal-neutron irradiated group, the number of leukocytes, lymphocytes, and neutrophils decreased in proportion to the radiation dose. However, there was no definite trend in changes in the API and the number of H-A because the doses of 250 to 400 rem were intermediate doses. Histological examinations showed signs of stress in the adrenal cortex and slight damage to the bone marrow, kidneys, and spleen; other organs had recovered. (NSA of Japan) (TSS)

31658 INHIBITING EFFECT OF ACTINOMYCIN D AND X-RAY IRRADIATION ON RNA SYNTHESIS INDUCED BY INFLUENZA VIRUS. Peterson, O. P.; Berezine, O. N.; Kantorovich, E. N. (Inst. of Virology, Moscow). Vop. Virusol., No. 5, 616-20(1967). (In Russian).

The synthesis of RNA induced by influenza virus as influenced at various stages of its reproduction by actinomycin D and x irradiation was studied. A 2-day old culture of chick fibroblasts was infected with influenza WSN, and uridine-2-^{14}C was used as the precursor of RNA synthesis. Actinomycin D was added in concentrations of 2 mkg/ml and at varying intervals after infection. Part of the culture was irradiated with 2000 R one hr prior to infection and the rest at hourly intervals after infection up to four hrs. The results showed that the most intensive suppression of RNA synthesis by actinomycin D and irradiation took place in the early stages of the infective process, namely, during the first three hrs. Synthesis was not significantly affected four hrs after infection, i.e., after RNA synthesis had begun. Administration of actinomycin D and x rays prior to infection inhibited RNA synthesis to a lesser degree than when administered one to three hrs after infection. It was concluded that irradiation and actinomycin D damaged mecha-

nisms that control the formation of the enzyme necessary for the synthesis of virus RNA. (ATD)

31659 STUDIES ON LIPIDS IN MATERNAL AND FETAL LIVER AND OF UNESTERIFIED FATTY ACIDS IN SERUM AFTER WHOLE-BODY-IRRADIATION OF PREGNANT RATS WITH 800 R. Haude, W.; Mohr, F.; Hartmann, D.; Goetze, E. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 22: 259-68(1969). (In German).

Studies on lipids in maternal and fetal liver and of unesterified fatty acids in serum after whole-body irradiation of pregnant rats with 800 R. Female rats in their 19th day of pregnancy were whole-body irradiated with 800 R of x radiation. Within 8 hrs following irradiation there was a three-fold increase in the triglyceride content of maternal and fetal liver over that of fed sham-irradiated rats, and a 50% increase over that of starved sham-irradiated rats. Four hrs after irradiation there was a 50% increase in the content of unesterified fatty acids in maternal serum. It was concluded that the radioinduced accumulation of lipids in both the maternal and fetal liver was the result of an increased mobilization of fatty acids in maternal fat depots due in part to the developing state of hunger. In comparison to triglycerides, other liver lipids (free and esterified cholesterol, total phosphatides) showed little or no change in their content. (E.R.B.)

31660 BLOOD CHOLINESTERASE ACTIVITY IN RADIATION TREATMENT OF LYMPHOGRANULOMATOSIS. Shcherban, E. I.; Belugina, Z. T.; Mtskhvetadze, A. V.; Labusheva, M. A. (Central Research Roentgeno-Radiological Inst., Moscow). Vop. Onkol., 15: No. 1, 47-51(1969). (In Russian).

The activity of cholinesterase in blood plasma and erythrocytes was studied in 54 patients with lymphogranulomatosis, in 12 healthy persons, and also experimentally on 11 cats. It was found that an average level of blood cholinesterase activity was markedly reduced in patients in comparison with sound individuals, and the index of cholinesterase activity was also reduced but insignificantly. The reduction of indices is aggravated with the involvement of hemopoietic systems, intraabdominal lymph nodes and liver. The intensive radiation treatment did not result in appreciable changes in blood cholinesterase activity in patients with lymphogranulomatosis. There was revealed a considerable reduction in the erythrocyte cholinesterase activity under the influence of total irradiation of cats with a dose of 800 R. (auth)

31661 DEPLETION OF LYMPHOCYTES BY EXTRA-CORPOREAL IRRADIATION OF BLOOD AND LYMPH. Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.). Nouv. Rev. Franc. Hematol., 8: 643-55(1968). (In French).

The theoretical and practical aspects of extracorporeal irradiation of the blood (E.C.I.B.) and lymph (E.C.I.L.) are reviewed. It was shown that there are pools of lymphocytes that are easily mobilizable and can be killed by E.C.I.B. or E.C.I.L. and another pool of lymphocytes that is relatively tightly held in the lymphoreticular tissue. The histologic aspect of depletion of the lymphoreticular tissues by E.C.I.B. and E.C.I.L. is characteristic. Its primary characteristics consist of depletion of lymphocytes surrounding germinal centers and depletion of the lymphocytes in the loose white pulp of the spleen and the cortex of lymph nodes. Whereas the depletion of lymphocytes surrounding the germinal centers is very extensive, approximately half of the lymphocytes in the cortex of the lymph nodes remain relatively tightly fixed. Depletion of lymphocytes in this manner opens avenues of basic and clinical investigation for study of allograft survival and regulation of lymphopoiesis. (auth)

31662 VARIATION IN ACTINOMYCES STREPTOMYCINI, THE PRODUCER OF STREPTOMYCIN, UNDER THE CONDITIONS OF REPEATED UV-TREATMENTS AND SELECTION BY STEPS FOR THE INCREASE OF PROTEOLYTIC ACTIVITY. Shishkina, T. A. (All-Union Scientific-Research Inst. of Genetics and Selection of Industrial Microorganism, Moscow). Genetika, 5: No. 4, 172-3(Apr. 1969). (In Russian).

It is shown that the uv rays in 500, 1000, 1500, 2000, and 2500 erg/mn doses induced changes in proteolytic activity of streptomycin resulting in higher percentage of minus variants. The cultures studied differed in the degree of mutability and proteolytic activity. (R.V.J.)

31663 CULTURE AGE AND CELLULAR RADIOSENSITIVITY. Revesz, L.; Littbrand, B. (Karolinska Institutet, Stockholm). Exp. Cell Res., 55: 283-4(May 1969).

Cultures of Chinese hamster cells were x-irradiated under anoxic and aerobic conditions and survival curves are given. It was found that recovery of cells from radiation injury is an oxygen-dependent process. The ratio between the survival after a single dose and the same dose split into two fractions was studied. When cells from one-day-old cultures were tested after exposure to anoxic radiation and the time interval between the split doses was 4 or 18 hr, the split-dose ratios were close to unity. When oxygen was present during the radiation exposure, split-dose ratios of 4 and 2 were calculated in experiments with cells from young and old cultures, respectively. (H.L.W.)

31664 A MODIFIED TISSUE EQUIVALENT LIQUID. Goodman, L. J. (Columbia Univ., New York). Health Phys., 16: 763(June 1969).

A well-known formulation of tissue equivalent liquid used for hard γ rays and neutrons is that of Rossi and Failla, based on the soft tissue approximation formula $(C_5H_{40}O_{18}N)n$; it is four-component, with a density of 1.11 g/cm^3. A modification of this liquid is described having the advantages of muscle composition, only three components, and density 1.07 g/cm^3. The four-component system contains water, glycerol, urea, and sucrose; the latter is omitted from the three-component system. (UK)

Immunology

31665 (LF-39, pp 217-21) EFFECT OF AGE, STRAIN, AND WHOLE-BODY X-IRRADIATION ON TRANSPLANTABILITY OF ^{90}Sr INDUCED CHLOROLEUKEMIA IN RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The susceptibility of Holtzman and Sprague-Dawley rats to ^{90}Sr-induced chloroleukemia was studied in 7- to 28-day-old rats given intraperitoneal injections of leukemic cells. A marked age-related increase in rejection was observed in Sprague-Dawley rats, whereas the tolerance for tumor transplant remained relatively unchanged with increasing age in the case of the Holtzman strain. Similarly, a marked increase in mean survival time was seen with increasing age in Sprague-Dawley rats, whereas little increase was observed in Holtzman rats. Exposure of 28-day-old Sprague Dawley rats to whole body x-irradiation resulted in an increase in tumor acceptance when doses of 400 rads were delivered. Lower doses of irradiation, 100 to 200 rads, resulted in no increased susceptibility. Although the presence of a radiation sensitive host versus tumor response was suggested when Sprague-Dawley rats were challenged with Holtzman-derived chloroleukemia, the nature of the sensitizing antigen remains unknown. Similarly, the explanation for the apparent enhanced tolerance of Holtzman rats to transferred tumor remains obscure. (auth)

31666 REFRACTORY PERIOD IN ADOPTIVE IMMUNIZATION FOLLOWING SECONDARY STIMULATION OF MICE. Twarog, Frank J.; Rose, Noel R. (State Univ. of New York, Buffalo). J. Immunol., 102: 375-80(Feb. 1969).

A refractory period of antibody transfer between eight and 20 days following a secondary stimulation of mice with bovine serum albumin (BSA) was observed. During this period, although donor animals had very high titers of BSA antibody, spleen and lymph node tissue was incapable of producing antibody when transferred to syngeneic recipients. Cells with immunologic memory, however, were present in the transferred tissue as attested by anamnestic responses elicited in the recipient animals with sub-immunogenic doses of BSA. This refractory period was related to the dose of antigen used in the booster injection. (auth)

31667 ANTIGEN-INDUCED CELL PROLIFERATIONS IN CULTURES FROM ANTIBODY-DEFICIENT CHICKENS. Meuwissen, H. J.; Van Alten, P. J.; Good, R. A. (Univ. of Minnesota, Minneapolis). J. Immunol., 102: 1079-83(Apr. 1969).

Bursectomized and irradiated, hypogammaglobulinemic chickens and irradiated controls were immunized with killed Brucella abortus. Cultures of splenic cells from these animals were subsequently stimulated with the same antigen. Hypogammaglobulinemic chickens did not produce antibody in vivo, but the uptake of tritiated thymidine after antigenic stimulation in vitro was unimpaired. The results indicate that lymphoid cell lines dependent on the bursa of Fabricius for development to immunoglobulin-producing cells are not necessary for a vigorous response to Brucella antigens in vitro. (auth)

31668 FACTORS MODIFYING HOST RESISTANCE TO VIRAL INFECTION. I. EFFECT OF IMMUNOSUPPRESSIVE DRUGS ON EXPERIMENTAL INFECTION OF MICE WITH ENCEPHALOMYOCARDITIS VIRUS. Murphy, Brian R.; Glasgow, Lowell A. (Univ. of Rochester, N. Y.). Antimicrob. Agents Chemother., 7th, 1967, 661-7(1968).

From 7th Interscience Conference on Antimicrobial Agents and Chemotherapy, Chicago, Ill. See CONF-671067.

Host defense mechanisms to viral infections remain poorly defined. An experimental model was developed that would permit further elucidation of the respective roles of interferon and neutralizing antibody in host resistance to viral infection. A striking

increase in mortality of mice due to encephalomyocarditis (EMC) virus was observed in whole-body x-irradiated mice and animals treated with a combination of cyclophosphamide and thioguanine. This enhanced susceptibility of mice was associated with the earlier appearance of virus in the blood, higher peak levels, and persistence of the viremia up to 2 days longer than in control mice. In both groups, clearance of the viremia was associated with the appearance in the serum of specific neutralizing antibody. The treated mice also developed higher levels of virus in the heart and brain. Clearance of EMC virus, injected by the intravenous route, in nonimmune mice was similar for treated and control mice. Interferon production was similar in all groups; thus, the observed increase in susceptibility does not appear to be a result of an altered interferon response. It is proposed that x irradiation and drug therapy delayed and depressed production of neutralizing antibody. The resultant decreased capacity to clear the viremia was associated with an increase in the level and duration of viremia, a greater inoculum of virus seeding the target organ, and greater tissue involvement. This work provides a model for further definition of the association between increased susceptibility to viral infections and an underlying immunosuppressive event. (E.R.B.)

31669 CHANGED TITRE OF HETEROPHILE ANTIBODIES IN PATIENTS WITH CANCER OF THE CERVIX UTERI IN THE RADIATION THERAPY. Luginina, A. S.; Nesyn, I. N.; Zakler, E. I. (First Clinical Hospital, Novosibirsk, USSR). Vop. Onkol., 15: No. 1, 37-40(1969). (In Russian).

The titre of heterophile antibodies (reps. of normal heterohemagglutinins to lamb erythrocytes) was determined in blood serum in 419 patients with cancer of female genitalia irradiated by x-rays. An average titre of antibodies in the first series was higher than that in the second. In 48 females suffering cervix uteri cancer, grade I–III, the dynamics of heterophile antibody titre was studied in the combined radiation treatment. The studies have demonstrated a statistically reliable increase of the antibody titre in the therapy. It is felt that the use of ionizing radiation in cancer of the uterine neck increases the protective function of the body RES. (auth)

31670 A RADIOIMMUNASSAY USING CELLULOSE-BOUND ANTIBODIES AND ITS APPLICATION TO STAPHYLOCOCCAL-α-TOXIN. Habermann, E. (Justus Liebig-Univ., Giessen, Ger.); Raeker, O. Arch. Pharmakol. Exp. Pathol., 263: 216-17(1969).

Staphylococcal α-toxin was iodinated with ^{125}I. Unlabeled and labeled toxin disappeared very quickly from the blood stream following injection into rabbits. Binding of the hemolysin to erythrocytes was negligible. The labeled toxin did not return into the blood stream when antitoxin was injected intravenously a few minutes later. Previous injection of antitoxic or normal bovine serum delayed the disappearance of labeled toxin. (H.L.W.)

31671 EVIDENCE FOR SIMILAR ANTIGENIC DETERMINANTS IN GONADOTROPINS FROM URINE OF MAN AND MONKEY (MACACA MULATTA). Tullner, William W.; Rayford, Philip L.; Ross, Griff T. (National Inst. of Health, Bethesda, Md.). Endocrinology, 84: 908-11(Apr. 1969).

Immunological properties of human chorionic gonadotropin (HCG) and monkey (Macaca mulatta) chorionic gonadotropin (MCG) were examined by biological and radioimmunological methods using a rabbit antiserum to HCG. Evidence for antigenic similarities of HCG and MCG was demonstrated by the capacity of this antiserum to neutralize biological activity in the mouse uterus weight assay and by competition with ^{131}I-labeled HLH for antibody binding sites in a radioimmunoassay system. Further, substances precipitable from the urine of normal female monkeys were antigenically similar to HCG in the radioimmunoassay system. (auth)

31672 SECONDARY DISEASE IN IRRADIATED MICE GRAFTED WITH ALLOGENEIC BONE MARROW FROM ANTI-LYMPHOCYTE SERUM-TREATED DONORS. Ledney, G. D.; van Bekkum, D. W. (Univ. of Tennessee, Memphis. Radiobiological Inst., TNO, Rijswijk, Netherlands). J. Nat. Cancer Inst., 42: 633-41(Apr. 1969).

Donor mice were treated with antilymphocyte serum (ALS) and antilymphocyte serum globulin (ALG) to ascertain the influence of these substances on the symptoms of, and mortality from, delayed secondary disease. Groups of donor C57BL mice received four consecutive daily injections of either ALS or ALG, and 24 hrs after the last treatment 20×10^6 bone marrow cells were transplanted into CBA mice that had received 875 rads radiation. As controls, other groups of donor mice were given normal rabbit serum (NRS), normal rabbit-serum globulin (NRG), or physiologic saline (NaCl) before their cells were grafted into irradiated mice. Weight loss from secondary disease occurred during the third week in mice grafted with marrow from NaCl- and NRG-treated donors and during the fourth week in mice grafted with marrow from NRS-, ALS-, and ALG-treated donors. Mortality from secondary disease began about 15–25 days after treatment when mice were grafted with marrow from NaCl- and NRG-treated donors and approximately 40 to 50 days after grafting when donor mice received NRS, ALS, or ALG. All mice grafted with marrow from NaCl-treated donors were dead within 60 days. Approximately 10% of the mice grafted with cells from NRS- or NRG-treated donors survived the 120-day observation period. Survival in mice grafted with cells from ALS-treated donors was about 10%, whereas 50% of the mice grafted with bone marrow from ALG-treated donors survived. (auth)

31673 IMMUNOLOGICALLY COMPETENT THYMUS CELLS OF BONE MARROW ORIGIN. Doria, G.; Agarossi, G. (CNEN-EURATOM, Rome). Nature (London), 221: 871-3(Mar. 1, 1969).

Experiments with lethally irradiated mice showed that the recovery of the immune response to sheep red blood cells by transplantation of bone marrow cells is conditioned by the host thymus, and that the thymus promotes differentiation of cells derived from the bone marrow to immunologically competent cells. The tissue in which cells from bone marrow acquire immunological competence under thymic influence has not, however, been identified, although that the thymus itself may be the site of this differentiation is suggested by the finding of donor mitotic cells of bone marrow origin in the host thymus of mouse radiation chimaeras. Although this shows migration of bone marrow-derived cells to the thymus, it does not indicate whether the donor cells detected in the thymus have gained any immunological competence. In the studies described thymus cells from isogeneic bone marrow radiation chimaeras were tested for immunological competence after transplantation and antigenic stimulation in lethally irradiated test mice. Results demonstrated the presence of immunologically competent cells in the thymus of antigenically unstimulated chimaeras, consistent with the idea that bone marrow cells migrated to the thymus of the chimaera host and there acquired immunological competence. The effects of the interaction between the thymus radioresistant epithelial cells and the marrow immigrant cells, which renders cells immunologically competent, are not understood, but two possible effects are considered. (UK)

31674 EFFECTS OF SOME CELLULAR ANTIGENS ON LYMPHOCYTES AND THE NATURE OF THE MIXED LYMPHOCYTE REACTION. Hardy, D. A.; Ling, N. R. (Univ. of Birmingham, Eng.). Nature (London), 221: 545-8(Feb. 8, 1969).

Irradiated lymphoma cells markedly activate human lymphocytes in a mixed cell reaction. HeLa cells (irradiated or disrupted), high concentrations of allogeneic erythrocytes, disrupted leucocytes or microsome preparations from spleen are all inactive. The question of whether the mixed lymphocyte reaction requires two populations of viable lymphoid cells is discussed. (auth)

31675 ACCUMULATION OF ANTIBODY-FORMING CELLS IN SPLEENS OF PREIMMUNIZED IRRADIATED MICE AFTER TRANSPLANTATION OF SYNGENEIC BONE MARROW. Zaretskaya, Y. M.; Panteleev, E. I.; Petrov, R. V. (Inst. of Biophysics, Moscow). Nature (London), 221: 567-8(Feb. 8, 1969).

Studies are described which show that accumulation of antibody-forming cells in lethally irradiated mice protected with syngeneic bone marrow requires the interaction of graft and recipient cells. The mice were immunized with sheep red blood cells, and 6 weeks later were ^{60}Co γ-irradiated to 1000 R. Some of the animals were given an intravenous transfusion of syngeneic bone marrow nucleated cells 24 hrs after irradiation, and others were re-immunized with the same antigen 4 days after irradiation; still others were not immunized before irradiation. Antibody-forming cells were determined by Jerne's method, and after the number of plaque-forming cells (PFC) per 10^6 nucleated spleen cells had been determined calculation was made for the whole spleen. Circulating haemagglutinins were also determined. Results are tabulated for average numbers of PFC per spleen. The studies may demonstrate new aspects of the activity of donor bone marrow in a radiation chimaera. There is probably a specific type of intercellular relationship as a result of which donor cells, and the substances they release, contribute to the restoration of recipient cells or thier functions involved in active antibody synthesis. On the other hand, it is possible that the introduced potentially immunocompetent donor cells assimilate antigenic information in the recipients' structures destroyed by irradiation, or obtain it from resistant cells of the recipient component, and are thus involved in the antibody synthesis. (UK)

31676 AN IMMUNOCHEMOTHERAPEUTIC SYSTEM FOR THE TREATMENT OF A TRANSPLANTED MOLONEY VIRUS-INDUCED LYMPHOMA IN MICE. Glynn, J. P.; Halpern, B. L.;

Fefer, A. (National Cancer Inst., Bethesda, Md.). Cancer Res., 29: 515-20(Mar. 1969).

The development of a system for the combined immunochemotherapeutic treatment of a lymphoma of BALB/c mice induced by Moloney virus is presented. Allogeneic cells specifically sensitized to the Moloney virus-induced transplantation antigen(s) in conjunction with Cytoxan can be used successfully to eradicate the lymphoma in a significant proportion of the animals. Cytoxan alone, while providing marked increases in survival time, did not eradicate the tumor. Treatment with the sensitized allogeneic cells alone was without effect. (auth)

31677 SPECIFICITY OF PROTECTIVE IMMUNITY PRODUCED BY X-IRRADIATED PLASMODIUM BERGHEI SPOROZOITES. Nussenzweig, R. S.; Vanderberg, J. P.; Most, H.; Orton, C. (New York Univ., N. Y.). Nature (London), 222: 488-9(May 3, 1969).

The general background of vaccination against malarial infections is outlined, and the aim of the work undertaken is stated to be determination of whether a strict strain and species specificity occurs in animals vaccinated with sporozoites, or whether a much broader spectrum of protective immunity develops. Protective immunity to sporozoites of P. berghei in mice can be produced by vaccination with x-irradiated sporozoites, making it possible to investigate the immunological relationship between the sporozoite and the blood stages of this parasite. In the studies described mice were immunized by repeated injection of P. berghei sporozoites x-irradiated at 8,000 R. The results of challenges with viable sporozoites indicated that these animals were effectively protected against viable sporozoites, not only of the homologous species, but also of P. vinckei. Cross protection was substantial. A lack of protection was, however, observed on challenge with the respective blood forms of these organisms. It was also found that inoculation with non-infected mosquito tissue failed to protect mice against sporozoites or blood forms of P. berghei, and in fact led to an accelerated course of infection. This excluded the possibility of a non-specific protective effect. (UK)

31678 INSULIN SECRETION BY THE OVINE FETUS IN UTERO. Willes, R. F.; Boda, J. M.; Manns, J. G. (Univ. of California, Davis). Endocrinology, 84: 520-7(Mar. 1969).

Twenty-nine experiments were conducted on 11 fetuses to assess the ability of the fetal sheep pancreas to secrete insulin in response to intravenous glucose (1.0 and 0.5 g/kg fetal body wt) and fructose (1.0 g/kg fetal body wt) challenges in vivo. A chronic vascular cannulation procedure was developed to conduct these studies. Intravenous glucose challenges were also conducted on six pregnant ewes and seven newborn lambs. Plasma insulin concentrations were measured by radioimmunoassay using ^{131}I-labeled insulin. Data obtained indicated that the fetal ovine pancreas did not respond to the glucose or fructose challenges by secreting insulin until after birth. Newborn lambs and pregnant ewes showed a significant insulin secretion to glucose challenges. These data were discussed with respect to development of the fetal pancreas and the role other hormones may play in insulin secretion. (auth)

31679 RADIOIMMUNOASSAY OF VASOPRESSIN WITH A COMPARISON OF IMMUNOLOGICAL AND BIOLOGICAL ACTIVITY IN THE RAT POSTERIOR PITUITARY. Miller, Myron; Moses, Arnold M. (Veterans Administration Hospital, Syracuse, N. Y. State Univ. of New York, Syracuse). Endocrinology, 84: 557-62(Mar. 1969).

Immunization of rabbits with lysine vasopressin (LVP) conjugated to bovine serum albumin resulted in the production of antibodies to LVP that were capable of cross reacting with arginine vasopressin (AVP). Using the antiserum and ^{125}I-LVP, a radioimmunoassay for AVP was developed that is sensitive and specific for vasopressin. The reliability and specificity of the assay were confirmed by performing simultaneous immuno- and bioassays for AVP on the posterior pituitaries of normally hydrated rats and rats subjected to varying periods of dehydration. A highly significant linear correlation was demonstrated when pituitary AVP content by immunoassay (Y) was plotted against pituitary AVP content by bioassay (X) ($Y = 1.15X + 81.05$, $r = 0.941$, $p < 0.001$). Good agreement occurred for the value of pituitary AVP content as determined by the assay methods, with immunoassay values being somewhat greater than those determined by bioassay. Following prolonged dehydration, there was a progressive parallel decrease in pituitary AVP content as determined by both immuno- and bioassay. It was thus established that the radioimmunoassay for AVP is a reliable, specific, and sensitive method, capable of quantitatively measuring biologically active AVP in physiological conditions known to affect pituitary AVP content. (auth)

31680 RADIOIMMUNOASSAY FOR BOVINE AND OVINE LUTEINIZING HORMONE. Niswender, Gordon D.; Reichert, Leo E. Jr.; Midgley, A. R. Jr.; Nalbandov, A. V. (Univ. of Michigan, Ann Arbor. Emory Univ., Atlanta. Univ. of Illinois, Urbana). Endocrinology, 84: 1166-73(May 1969).

Separate radioimmunoassays for bovine and ovine luteinizing hormone (LH) were developed. Antiserum against LH was developed in rabbits and purified preparations of bovine and ovine LH were used for radioiodination. Specificity of the assays was demonstrated by comparing radioimmunoassay and bioassay estimates of the LH content of pituitary preparations containing various ratios of the pituitary hormones. Using the bovine LH radioimmunoassay and 200 μl aliquots of serum, relatively high levels (12 to 60 mg/ml) of LH were measured in serum from heifers on the day of estrus and measurable levels of LH were present in serum from castrated males (3 to 5 ng/ml). The ovine LH assay serum obtained from ewes on the day of estrus contained an average of 26 ng/ml, whereas serum obtained during the follicular and luteal phases of the cycle contained approximately 2 ng/ml. The average LH content of serum from castrated ewes was 4.9 ng/ml, whereas the level in castrated males was 20.9 ng/ml. Serum from normal male sheep contained an average of 2 ng/ml, while serum from a hypophysectomized ewe had no detectable LH (<0.5 ng/ml). (auth)

Ecology

31681 ANALYSIS OF TRANSIENT BEHAVIOR OF RADIOISOTOPES IN INSECT FOOD CHAINS. Crossley, D. A. Jr.; Reichle, David E. (Oak Ridge National Lab., Tenn.). Bioscience, 19: 341-3(1969).

In a Liriodendron stand labeled with ^{137}Cs, the litter horizon received an annual pulse of labeled falling leaves. For arthropods feeding on this litter the change in ^{137}Cs concentration with time is given by an intake-loss balance equation. The patterns of accumulation revealed by field sampling were analyzed to yield estimates of average loss rates for entire tropic levels. A mathematical model describing such transient behavior is presented; its application is illustrated with laboratory and field data. Graphs are presented to show theoretical accumulation of ^{137}Cs in saprophagous arthropods from their leaf litter food base following autumn leaf drop; accumulation of ^{134}Cs in a millipede, Dixidesmus erasus, in laboratory studies; and seasonal fluctuation of ^{137}Cs concentration in leaf litter, saprophagous and predaceous arthropods in a Liriodendron stand experimentally tagged with ^{137}Cs. (H.L.W.)

31682 TRANSPORT OF FALLOUT RADIONUCLIDES IN THE GRASS-TO-MILK FOOD CHAIN STUDIED WITH A GERMANIUM LITHIUM-DRIFTED DETECTOR. Potter, Gilbert D.; McIntyre, David R.; Pomeroy, Deborah (Univ. of California, Livermore). Health Phys., 16: 297-300(Mar. 1969).

Fallout, presumed to have originated from the Chinese nuclear test of 28 December 1966, as deposited in Northern California on 1 and 2 January 1967 was studied. The transfer of radionuclides in dry fallout from pasture grass to cows' milk was studied with a germanium lithium-drifted detector. The radionuclides on the grass and in the milk were identified and specific nuclides were quantitated from the resulting gamma spectra. The particular "family cow" observed was probably a worst-case example for dry fallout in that almost all of its nutritional requirements were derived from a small pasture. The observed value of the ^{131}I in the milk of this cow, 934 pCi of ^{131}I/kg, could have been higher under rainout conditions. The study demonstrates the value of the new solid-state germanium lithium-drifted detector for those working in the field of radioecology. (auth)(UK)

31683 CONDITIONS FOR COEXISTENCE OF AQUATIC COMMUNITIES WITH THE EXPANDING NUCLEAR POWER INDUSTRY. Davis, W. S. Nucl. Safety, 10: 292-9(July-Aug. 1969).

Communities of aquatic plants and animals cannot indefinitely withstand indiscriminate use of their environment for disposal of the thermal, radioactive, and chemical waste of nuclear and fossil-fueled thermoelectric production. The diversion of large quantities of water for use in cooling condensers may also be harmful. Although developing water-quality standards will limit introduction of such wastes into interstate and coastal waters, they will not regulate specifically the amount of water taken into power plants for cooling. New regimes of temperature, radioactivity, and chemistry will be established in many interstate and coastal waters when the limits imposed by water-quality standards and licensing authorities are attained nationwide. The efforts of aquatic biologists and engineers must be complementary to ensure wise use of the water resources of the nation. (auth)

Genetics and Cytogenetics

Refer also to abstracts 31905, and 32002–32004.

31684 (LF-39, pp 174-8) USE OF METAPHASE CHROMOSOMES OF LIVER FOR ASSESSING RADIATION DAMAGE. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Following surgical partial hepatectomy, the peak of the mitotic index in Chinese hamster regenerating liver cells was found to be 54 hours. Using this information, the number and types of chromosomal abnormalities present following exposure to 150 roentgens of cobalt-60 gamma irradiation delivered during varied portions of the cell cycle were determined. Exposing the animals at −1, 24, and 48 hours post-partial hepatectomy there were 0.08, 0.13 and 0.10 breaks/cell/150 R observed, respectively. A change from a preponderance of chromosome to chromatid-type aberrations was observed as the time between exposure and sacrifice decreased. (auth)

31685 (NYO-3893-10) ULTRAVIOLET LIGHT EFFECTS ON NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA. Progress Report. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia, Pa. Dept. of Genetics). Apr. 1969. Contract AT(30-1)-3893. 10p. Dep. CFSTI.

Loss of photoreversibility of UV-induced mutation to streptomycin resistance and lethal damage in an hcr^+ strain of Escherichia coli occurs during the first 20 min of postirradiation incubation and is unaffected by absence of tryptophan with an amino acid-requiring substrain or by absence of thymine with a thymine-requiring substrain but is blocked by dinitrophenol. The initial postirradiation replication of DNA which begins after 40 min of incubation is significant in the mutation process since expression of streptomycin resistance (measured in streptomycin-containing agar medium blocking protein synthesis) does not occur unless DNA replication is allowed before plating and is thymine-dependent. Loss of photoreversibility of str-r mutations and lethal damage in an hcr^- strain of E. coli begins after 20 min of incubation and requires 80 min for completion and is tryptophan-dependent and thymine-dependent. Unlike str-r mutation, loss of photoreversibility of suppressor mutations in a tryptophan-requiring strain is correlated with DNA replication even in hcr^+ bacteria and is amino and thymine-dependent in hcr^- bacteria. (auth)

31686 (STI/PUB-212) NEW APPROACHES TO BREEDING FOR IMPROVED PLANT PROTEIN. Panel Proceedings Series. Proceedings of a Panel Meeting Held in Roestanga, Sweden, 17–21 June 1968. (International Atomic Energy Agency, Vienna, (Austria)). 1969. 199p. (CONF-680655). IAEA: $5.00; Austrian Schillings 130,-; £2.1.8; F. Fr. 24,50; DM 20,-.

Seventeen papers are included in these proceedings. They discuss the need for protein (1), breeding for protein improvement (10), and analytical screening methods (6). Separate abstracts were prepared for three of these papers, one on radio-induced mutations in barley and wheat for improved proteins, and one each on nitrogen determination in seeds by neutron- and proton-activation analysis. (E.R.B.)

For abstracts of individual papers see: 31306, 31307, and 31687.

31687 GENETIC CONTROL OF THE QUALITATIVE AND QUANTITATIVE PRODUCTION OF ENDOSPERM PROTEINS IN WHEAT AND BARLEY. Favret, E. A.; Solari, R.; Manghers, L.; Avila, A. (Instituto de Fitotecnia, Castelar, Argentina). pp 87-107 of New Approaches to Breeding for Improved Plant Protein. Vienna, International Atomic Energy Agency, 1969.

From Panel Meeting on New Approaches to Breeding for Improved Plant Protein, Roestange, Sweden. See STI/PUB-212; CONF-680655.

Injured mutagenesis can be used to obtain barley strains that produce a higher amount of protein in the endosperm and larger seeds. The simultaneous combination of both characters would permit a two-fold increase in the protein agronomic yield. It is also possible to induce mutations with a higher carbohydrate reserve in the seed, maintaining the protein content at the same level. Mutations can also be induced in wheat that alter the baking qualities of its gluten. These modifications are associated with changes in the different types of endosperm protein. The production of specific protein in the endosperm of wheat and barley is governed by nuclear genes. The production of a protein is regulated by the allelic dosage present in the triploid endosperm. In this manner alleles that require single, double, or triple doses to manifest themselves are distinguished. This fact provokes different results in the reciprocal F_1 crosses, depending on the genetic constitution of the plant used as female. Silent alleles exist, i.e., those considered unable to produce protein. The presence of structural genes and regulatory genes is suggested and their importance in induced mutagenesis is mentioned. (auth)

31688 A STUDY OF VARIABILITY IN BACILLUS MESENTERICUS INDUCED BY THE COMBINED ACTION OF DIFFERENT MUTAGENS. Pasichnyk, A. M.; Luginina, T. M. Mikrobiol. Zh., No. 5, 443-50(1968). (In Russian).

The combined effects of ethylenimine and ultraviolet radiation on a culture of the PB-8 strain of Bacillus mesentericus were investigated. A 0.05% solution of ethylenimine was used in combination with 15 minutes exposure to the radiation (400 erg/mm^2). Fast neutrons were also used in combination with the same chemical (10 Krad; 0.014% solution). As a result of the experiments, mutants of the PB-8 strain were obtained that exhibited increased spore production, greater sensitivity to the culture medium, and greater activity of enzymes produced. Similar tests were run with Bacillus mesentericus 7099, as a result of which an enzyme preparation was obtained that is now being used for the restoration of triacetate film. (JPRS)

31689 BASE SPECIFIC CHEMICALS AND MUTATION ANALYSIS IN LYCOPERSICON. Jain, H. K.; Raut, R. N.; Khamankar, Y. G. (Indian Agricultural Research Inst., New Delhi). Heredity, 23: 247-56(May 1968).

Hydrazine, hydroxylamine, and ethyl methane sulfonate (EMS) were tested for their mutagenic effects on the tomato plant, and their effects compared with that of ^{60}Co γ irradiation in doses of of 30 to 40 Krad. The treatment with mutagens affected seed germination so that the number of M_1 seedlings varied from 35.8 to 64.6% of the treated seeds in the case of the different hydrazine treatments. The corresponding values in the case of hydroxylamine, EMS, and γ radiation were 28.2 to 50.2, 32.0 to 69.6 and 48.6 to 64.8% respectively. Compared to the chemical mutagens, γ radiation was significantly less effective in inducing mutation at most of the loci. For example, none of the radiation treatments yielded a dwarf mutant in the M_1 generation, while all the different hydrazine treatments did so. Other studies have shown that radiation treatments do induce gene mutations in tomato of the type described here, but in none of these earlier studies, however, have mutants of the recessive type been observed in the M_1 generation, except perhaps with relatively insignificant frequencies. Further, the radiation-induced variation does not appear to be restricted to a particular group of genes. Some genes were particularly sensitive to hydrazine. Homozygous mutants for a number of these genes were consistently obtained in the M_1 generation following treatment of seeds with this chemical. These genes were little affected by other chemical mutagens, which did, however, induce mutation at some other loci. Several of the hydrazine-sensitive genes, like 16% of the 150 genes mapped in tomato, are in chromosome 2. (BBB)

31690 INDEPENDENT SEGREGATION OF CHLORAMPHENICOL RESISTANCE IN STAPHYLOCOCCUS AUREUS. Sabath, Leon D.; Gerstein, Deborah A.; Loder, P. Bronwen; Finland, Maxwell (Boston City Hospital, Harvard Medical School, Boston). Antimicrob. Agents Chemother., 7th, 1967, 264-70(1968).

From 7th Interscience Conference on Antimicrobial Agents and Chemotherapy, Chicago, Ill. See CONF-671067.

In three clinical isolates of chloramphenicol-resistant Staphylococcus aureus, the rates of spontaneous loss of resistance to chloramphenicol during a single transfer were 0.05, 0.17, and 0.71% of the colonies derived from single resistant colonies. The loss of chloramphenicol resistance was the result of the inability of cells to produce the enzyme chloramphenicol acetyl transferase. The segregation of chloramphenicol resistance occurred independently of resistance to the other antibiotics tested. Chloramphenicol acetyl transferase-negative colonies did not regain the ability to synthesize this enzyme on subsequent transfers. In one isolate, the spontaneous rate of loss of chloramphenicol resistance (0.71%) was not significantly increased by exposure to acriflavine, prolonged storage at 37 C, or exposure to 44 C for 4.25 hr. However, the incidence of segregation of chloramphenicol resistance was significantly increased by exposure to uv light, growth at 43 C for 6 hr, or by repeated subcultures at 37 C. These findings are consistent with a plasmid locus for the determinant of chloramphenicol resistance. (auth)

31691 EMBRYO SAC DEVELOPMENT IN RELATION TO POLLEN FERTILITY IN RADIATION INDUCED LAMBERT CHERRY MUTANTS. Eaton, G. W. (Univ. of British Columbia, Vancouver). Radiat. Bot., 8: 515-17(Dec. 1968).

Embryo sac development was examined for two years in a series of Lambert cherry clones, including radiation induced mutants which showed a wide range of pollen fertility. In comparison to clones of normal pollen fertility, reduced pollen fertility was associated with retarded embryo sac development, and a higher proportion of multiple embryo sacs, embryo sac degeneration, and irregularities. (auth) (UK)

31692 RADIATION RESPONSE IN RELATION TO THE CELL CYCLE IN VIVO. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 734-45(Apr. 1969).

TdR-^{3}H percentage labeling indices, mitotic indices, and the frequency of anaphase-telophase chromosomal aberrations have been used to examine the influence of the cell cycle stage on the response to x radiation in vivo. A high degree of synchronization was obtained in proliferating parenchymal cells after partial hepatectomy in the regenerating liver of the young male rat, and animals were irradiated (700 rads) prior to synchronization (G_0 cells), and at 14 hours (late G_1 cells), 25 hours (late S cells), 30 hours (G_2 cells), and 32.5 hours (M cells) after synchronization. Modification to DNA synthesis and mitotic and division delay were measured at frequent intervals during the first cell cycle after irradiation, and the frequency of chromosomal aberrations was determined during the first postirradiation cell division at 33 hours after synchronization. The data indicated that for proliferating parenchymal cells in vivo, modification to DNA synthesis and mitotic delay were greatest when cells were irradiated during the late G_1 phase, less in the G_2 phase, and least in the late S and G_0 phases. Radiation-induced chromosomal aberrations occurred most frequently in G_2 cells, less in late G_1 cells, and least in late S and G_0 cells. The results are discussed in terms of experimental studies on radiation effects and radiosensitivity during the generation cycle in plant cells and mammalian cells in vitro, and of age-response functions in relation to growth and cell division, biochemical effects of DNA synthesis, and chromosomal aberrations affecting the regenerative capacity of the proliferating parenchymal cell system. (auth)

31693 INDUCED MUTATIONS IN BREAD WHEAT. Goud, J. V. (Indian Agricultural Research Inst., Delhi). Indian J. Genet. Plant Breed., 27: 40-55(Mar. 1967).

The frequency and spectrum of macromutations induced by some physical and chemical mutagens in different varieties of bread wheat are reported. The efficiency of treatment with ^{60}Co γ rays, fast neutrons, and ethylmethane sulfonate (EMS) in producing mutations in qualitative characters was evaluated in six varieties (N.P. 876, N.P. 872, N.P. 870, N.P. 868, N.P. 863, and N.P. 862). Treated and control seeds of all the six varieties were sown in the field. The growth and survival was much inhibited in EMS treatments and 30-KR γ irradiation. N.P. 870 was much less affected by EMS treatment as compared to N.P. 876, while the latter was relatively more resistant to γ irradiation. About 10 and 35% of chimeras (chlorophyll + ear) were observed in γ ray- and EMS-treated plants, respectively, in the M_1 generation. The spectrum and frequency of visible mutations were studied in M_2 generation. The chlorophyll and viable mutation frequency was very high after EMS treatments and less after γ irradiation. The mutation frequency varied with variety; N.P. 870 was highly mutable whereas N.P. 862 was stable, with the other varieties falling in between. γ Irradiation produced more of albino and speltoid mutations, whereas EMS produced more of xantha, viridis, subcompactoid, compactoid, and spherococcoid mutations. The mutation spectrum was considerably increased after EMS treatments. (BBB)

31694 INFLUENCE OF NON-LETHAL DOSES OF RADIATION ON ALLELIC RECOMBINATION IN CHLAMYDOMONAS REINHARDI. Lawrence, C. W. (Wantage Research Lab., Eng.). Genet. Res., 9: 123-7(Feb. 1967).

The influence on allelic recombination of non-lethal doses of gamma radiation delivered at different stages during meiosis was determined and the data compared with previous results concerning gene recombination. Both kinds of recombination are influenced at only two (probably the same two) meiotic stages. During the first sensitive stage, probably in preleptotene, the frequency of allelic recombination is increased, but that the gene recombination decreased. The frequency of both is increased during the second sensitive stage, which is probably in pachytene. (auth)(UK)

31695 PROTECTION AGAINST RADIATION-INDUCED CHROMOSOME BREAKAGE IN VICIA FABA BY DIMETHYL SULFOXIDE. Kaul, B. L. (Max-Planck Institut fuer Zuechtungsforschung, Cologne). Radiat. Bot., 9: 111-14(Mar. 1969).

Experiments were performed to test if dimethyl sulfoxide (DMSO) reduces the radiation-induced chromosome breakage in Vicia faba. This substance was found previously to give significant protection against radiation damage in animals. A pretreatment with 1 to 3% DMSO was found to give up to 52 per cent reduction in total chromosomal aberrations, while post treatments had no effect. Radical scavenging or a direct interaction with the radiation process is believed to be the possible protective mechanism. (auth)(UK)

31696 PHOTOREACTIVATION OF MUTATIONS INDUCED BY ULTRAVIOLET RADIATION OF MAIZE POLLEN. Fujii, Taro (National Inst. of Genetics, Misima, Japan). Radiat. Bot., 9: 115-23(Mar. 1969).

A normal strain with genes of Yg_2, c, and Bz, and strain No. 641 with genes of yg_2, C, and bz were used as male and female parents, respectively. Pollen grains of the normal strain were exposed to ultraviolet radiation. Half of the irradiated pollen grains were exposed to visible light for 30 min and then pollinated to the female stock in the field under sunlight, whereas the other half were held for 30 min in dark and then pollinated to the female parent in a room illuminated by non-photoreactive sodium light. For purposes of comparison γ-ray irradiated pollen grains were subjected to similar posttreatments. Total frequency of mutation from Bz to bz (sum of the frequencies of whole and partial mutations) increased with dose both for uv and γ-ray treatments. After the photoreactivation treatment, mutation frequency markedly decreased for the uv lots; photoreactivation occurred to the same order of extent both for wholes and partials. No significant photoreactivation was observed for γ-ray induced mutation. Photoreactivation was also observed for the uv mutation at Yg_2 locus, though to a lesser extent than for the Bz locus, whereas no significant photoreactivation occurred for γ-ray induced mutation at this locus. These results are briefly discussed in relation to the mechanism of photoreactivation, with particular reference to results obtained by other workers. (auth)(UK)

31697 CAMPELIA ZANONIA (L.) H.B.K.: A NEW MATERIAL FOR THE STUDY OF RADIATION-INDUCED CHROMOSOMAL ABERRATIONS. Savage, John R. K.; Pritchard, M. Anne (Medical Research Council, Harwell, Eng.). Radiat. Bot., 9: 133-9(Mar. 1969).

A description of the material, together with some basic radiobiological information, is given for Campelia zanonia (L.) H.B.K. (Commelinaceae; Tradescantiae-Hexandrae). In most respects its response to radiation is virtually identical to that of Tradescantia paludosa. (auth)(UK)

31698 RADIOSENSITIVITY OF INDUCED PEA MUTANTS. Sidorova, K. K.; Khvostova, V. V.; Kalinina, N. P. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika, 5: No. 4, 5-12(Apr. 1969). (In Russian).

The radiosensitivity of 14 constant mutant strains of Pisum sativum ($M_5 - M_7$) obtained experimentally from the Torsdag variety was studied. Radiosensitivity was estimated from the frequency of cells with chromosome aberrations in first mitoses of meristematic cells of rootlets. Repeated fixations made it possible to study during the first mitotic cycle the chromosome aberrations induced at different interphase stages (G_1, S, G_2). It is established that a half of the mutants studied is characterized by a relatively high natural mutability. The maximum number of cells with chromosome aberrations per cell cycle in such mutants varied from 2.7% to 4.9%, the initial variety having 1.3% (the difference is statistically significant). The exposure of seeds to x-radiation (5 kr.) resulted in significant differences in radiosensitivity between the mutants and the initial variety. Nine mutants were more radiosensitive, than the initial variety. The maximum number of cells with chromosome aberrations per cell cycle in the meristematic cells of rootlets varied in these mutants from 35.7% to 65.1%, being 29.3 in the initial variety (the difference is statistically significant). Only two mutants were more resistant to irradiation, the number of cells with chromosome aberrations being lower than in the initial variety (17.1% and 19.3%, respectively). No correlation between the natural and induced mutability was observed. Likewise no connection between the radiosensitivity of mutants and their specific morphological features were established. (auth)

31699 STALK ELONGATION IN MUTANTS OF CAULOBACTER CRESCENTUS. Schmidt, Jean M. (Arizona State Univ., Tempe). J. Gen. Microbiol., 53: 291-3(Oct. 1968).

Ultraviolet-radiation-induced morphological mutants of C. crescentus, which undergo extensive stalk elongation when grown on complex medium, were isolated by an indirect selection technique. Wild-type C. crescentus is known to produce a similar morphological defect when grown under conditions of severe phosphate limitation. For induction of mutants the bacteria were irradiated 3 to 4 min at a distance of 14 cm with a Mineralite USV-11 lamp. This treatment gave 1 to 0.1% survival. The maximum stalk length of the mutants was 20 μ, as compared with 2 to 3 μ for the parent strains. In these mutant strains, stalk synthesis proceeded in individual bacteria as long as they remained viable. This was in contrast to the wild-type bacteria cultivated on complete medium, where stalk growth reached completion within the first few generations. The mutants had no organic growth factor requirements, but their growth rates

were considerably slower than those of the wild-type strains. Two mutants showed conditional phenotypic reversion to normal stalk formation when cultivated in the presence of relatively high inorganic phosphate concentrations (10^{-2}M). No ultrastructural defects in the mutants were noted, other than the excessive stalk length. Genotypic reversion rates for back-mutation to short stalk formation were estimated. (BBB)

31700 INDUCED VARIATION IN A QUANTITATIVE CHARACTER IN BARLEY: MORPHOLOGY AND CYTOGENETICS OF ERECTOIDES MUTANTS. Persson, G.; Hagberg, A. Hereditas, 61: 115-78(1969).

Use of uv, x, γ, proton, and neutron irradiations to produce mutations in spike internode length in barley is reported. Dense spike mutants were referred to as erectoides or ert mutants. The mutability of 6 ert loci, each with 8 alleles or more, after treatment with sparsely ionizing radiation (x and γ rays), densely ionizing radiation (neutrons, protons), and 2 chemical agents was compared. Ert-a mutated more frequently after treatment with sparsely ionizing as compared with densely ionizing radiation. For ert-c, on the contrary, densely ionizing radiation seemed to be more efficient. However, it is possible that ert-a mutates at a high frequency also following treatment with densely ionizing radiation, but the effect of such an induced change in this locus seems to be lethal. Two loci are represented by alleles absolutely linked to translocations. Thus 6 alleles in ert-c and 1 allele in ert-d carry a translocation. All these translocations are induced by ionizing radiation. Lax as well as dense mutants were isolated. Variation in spike internode length was found to be only slightly affected by environmental variation, and therefore this material was considered suitable for investigations on the genetics of quantitative characters. A detailed morphological examination of ert mutants was made. Measurements were made on spike density, the character changed in all ert mutants, straw length, and length of straw internodes. Variation of quantitative as well as qualitative characters within the material was great. The biochemical background of the ert mutations is discussed. (BBB)

31701 CYTOGENETIC VARIABILITY IN RADIOINDUCED MOUSE LEUKEMIA. Ilbery, P. L. T.; Winn, S. M.; Barnes, C. A. (Univ. of Sydney). Brit. J. Cancer, 22: 743-54(Dec. 1968).

Cytogenetic results are reported for mice used in radiation experiments during the last 5 yr and which subsequently exhibited macroscopically leukemia of the thymic type. Mice of both sexes between 30 and 40 days of age received 4 doses of 180 or 200 rad each at 4-day intervals of ^{60}Co γ rays. The inbred strains employed were C57BL, CBA, DBA, and T6T6. Limitations were imposed by the morphology of mouse chromosomes in the assessment of variability in radiation-induced leukemia. Within these restrictions, chromosome analysis of 43 primary and transplanted radiation-induced leukemias showed 36 well-marked evidence of variation from the normal in chromosome number or form. The variation was mainly within the immediate hyperdiploid range 41 to 48 but minor modes were seen also about 50 and 70 as well as a leukemia with a definite hypodiploid stem cell line. The question of variation of other leukemia lines in the hypodiploid direction is discussed. Inspection of the aberrations of chromosome number and form within the thymus and the distribution of distinctive clones and classes within the pooled tissues were consistent with the naked eye appearance of an origin of the radiation induced neoplasm within the thymus. (BBB)

31702 LASER ABLATION OF MATERNAL CHROMOSOMES IN EGGS OF RANA PIPIENS. McKinnell, Robert G.; Mims, Martha F.; Reed, Louis A. (Newcomb Coll. of Tulane Univ., New Orleans). Z. Zellforsch. Mikroskop. Anat., 93: 30-5(Nov. 25, 1968).

A method of eliminating maternal meiotic chromosomes with laser irradiation is reported. A ruby laser (6943 Å) mounted on a compound microscope was shown to be effective in eliminating chromosomes of leopard frog (R. pipiens) eggs. Haploid embryos were produced by laser irradiation of maternal meiotic chromosomes in inseminated eggs. Inseminated control eggs, both sham laser irradiated and untreated, developed as diploid embryos. Chromosome number of all embryos was ascertained by aceto-orcein squashes of tadpole tail-tips. Diploid nuclei, transplanted to laser-irradiated unfertilized eggs, yielded embryos of chromosome number appropriate to the transplanted nucleus. The nuclear transplantation experiment provided additional evidence of the efficacy of the chromosome ablation procedure. Cytoplasmic damage, due to laser irradiation of the type described, did not prevent nuclear-transplant animals from developing beyond metamorphosis. (BBB)

31703 THE EFFECTS OF X-RAYS ON THE BRONZE AND SHRUNKEN LOCI IN MAIZE. Mottinger, John Philip. Bloomington, Ind., Indiana Univ., 1968. 94p.

Thesis.

A study was made of the effects of x-irradiation on the Bz locus in chromosome 9 of maize. The work of Stadler and Roman indicated that x-rays applied at a post-meiotic stage of pollen development produce only extragenic events. Since their study was confined to a single locus (A_1), a search for intragenic mutations at a second locus following x-irradiation was deemed appropriate. Pollen of Sh Bz Wx homozygotes was x-rayed and applied to silks of sh bz wx tester plants. Of 132,957 F_1 plants, 837 exhibited the bronze phenotype. Two plants of Sh bz* Wx/sh bz wx constitution (the bz-X1 and bz-X2 mutants) were selected for more intensive study as well as two plants with nearly normal pollen in which both Sh and Bz markers were mutated (sh-bz-X1 and sh-bz-X2). All of the remaining plants proved to be double mutants of sh* bz*/sh bz or bz* wx*/bz wx constitution with high pollen abortion. They were assumed to be heterozygous for deletions in chromosome 9 and were not analyzed further. The bz-X1 and bz-X2 mutations were classified as small deletions since a high frequency of abnormal pollen was observed in bz-X1 and bz-X2 heterozygotes, transmission was absent or low in male gametophytes and greatly reduced in female gametophytes, and crossing over in the Sh-Bz region was significantly less than in controls. A test of viability of bz-X1 and bz-X2 homozygotes was not possible because of the total absence or extreme infrequency of transmission in the male gametophyte. The sh-bz-X1 and sh-bz-X2 mutations were putative deletions since more than one locus was affected by x-rays. In the case of sh-bz-X1, tests of transmission and crossing over in heterozygotes confirmed this prediction. Although the frequency of subnormal pollen grains was low in sh-bz-X1 heterozygotes, the frequency of aborted grains was significantly higher than in control plants. Only 1% of pollen grains with sh-bz-X1 were functional, while 63% of the embryo sacs were viable. Crossing over did not occur in the Sh-Bz region and was reduced in the adjacent Bz-Wx segment. Inconclusive results were obtained in tests of zygotic lethality of sh-bz-X1 homozygotes. It was concluded that sh-bz-X1 is a deficiency involving both the Sh and Bz loci. It was concluded that all four of the selected mutations induced by x-rays can be classified as extragenic events. Although intragenic mutations might conceivably be detected in larger populations or with irradiation at premeiotic stages, the work with the Bz locus is in agreement with the results of Stadler and Roman on A_1. Both investigations indicate that the vast majority of changes produced by x-rays in maize are extragenic. (Disser. Abstr.)

31704 COMPONENTS OF THE GENETIC REPAIR MECHANISM ARE NOT CONFINED TO THE NUCLEUS. Holliday, R.; Resnick, M. A. (National Inst. Medical Research, London). Nature (London), 222: 480(May 3, 1969).

It was known that radiosensitive mutants in separate genes, presumably affecting different steps in the repair of damaged DNA, could complement in Escherichia coli, yeast, and Ustilago diploids. The question arose as to whether such strains could complement each other's deficiencies in heterokaryotic cells; such complementation would not be expected if the repair mechanism was completely confined to the nucleus. It was reported that mutants of Neurospora which were several times more sensitive to the lethal effects of uv light than the wild type could complement in heterokaryons. A study with three radiosensitive (UVS) mutants of Ustilago maydis, believed to be deficient in ability to repair damaged DNA is reported. Heterokaryotic cells were irradiated with 960 ergs/mm^2/uv light, which dose killed about 20% of wild type cells and at least 98% of UVS cells, and survival counts were made. It was concluded from the data that components of the repair mechanisms are diffusible between nucleus and cytoplasm, and therefore not completely confined to the nucleus, and that DNA outside the nucleus might also be repaired by the same mechanism as damaged nuclear DNA. (UK)

31705 LAMBDA PHAGE MUTANTS INSENSITIVE TO TEMPERATURE-SENSITIVE REPRESSOR. I. ISOLATION AND GENETIC ANALYSIS OF WEAK-VIRULENT MUTANTS. Horiuchi, Tadao (Kyushu Univ., Fukuoka); Koga, Hideo; Inokuchi, Hachiro; Tomizawa, Jun-ichi. Mol. Gen. Genet., 104: 51-8(1969).

Weak-virulent mutants of temperate coli-phage λ were isolated following uv irradiation that could grow on the λCIts lysogen producing a temperature-sensitive repressor but could not grow on the wild type λ lysogen producing a normal repressor. Genetic analysis on the mutants showed that their weak-virulence was attributable to two mutations, one (virL) in the region between sus N_{213} and c_{17} and the other (virR) in the region between c_1 and sus O_3. Both mutations were located within the region of non-homology between λ and λimm^{434} phages. True virulent mutants that could grow on the wild type λ lysogen were obtained easily from the weak-virulent mutant by an additional mutation, virC in a region very close to virR. The virulent mutants obtained were similar to the classical λvir mutant. The virL and virR mutations were probably operator mutations that rendered the genome insensitive to the λ repressor. (auth)

31706 CHEMICAL MUTAGENESIS IN E. COLI B/R: THE INFLUENCE OF REPAIR SYSTEMS FOR UV DAMAGE. Clarke, C. H. (Univ. of East Anglia, Norwich, Eng.). Mutat. Res., 8: 35-41(July-Aug. 1969).

Broth-grown cells of the Escherichia coli B/r try$^-$ auxotroph WWP-2 exhibit the following properties when treated with ultraviolet light, di-epoxybutane or nitrosomethylurethane. Late lag phase cells show, after ultraviolet-irradiation, a strong influence of caffeine upon survival and revertant frequencies. There is also a large enhancement of revertant frequencies in the presence of an amino acid pool. No such effects are found for di-epoxybutane or nitrosomethylurethane-treated cells. There is, however, a weak synergistic effect of caffeine plus an amino acid pool on di-epoxybutane-induced revertant frequencies. Stationary phase cells show decreased survival and increased revertant frequencies, after ultraviolet irradiation, when platings are made on minimal medium, plus a low level of tryptophan, supplemented with caffeine. There is a weak enhancement of revertant frequencies by enrichment of the low tryptophan medium with an amino acid pool. When caffeine is combined with the amino acid pool there is a greater than additive enhancement of revertant frequencies. Caffeine and an amino acid pool are, individually, without obvious effect on survival or revertant frequencies obtained following treatment with nitrosomethylurethane or di-epoxybutane. For cells treated with di-epoxybutane there is a weak synergistic effect of caffeine plus an amino acid pool on revertant frequencies. (auth)

31707 COMPARISON OF THE COMPLEMENTATION AND GENETIC MAPS OF CLOSELY LINKED NONALLELIC MARKERS ON LINKAGE GROUP I OF NEUROSPORA CRASSA. de Serres, F. J. (Oak Ridge National Lab., Tenn.). Mutat. Res., 8: 43-50(July-Aug. 1969).

Homology tests between ad-3^{IR} mutations and various strains carrying markers with known biochemical requirements or markers resulting from mutation of genes with unknown functions have been used to construct a complementation map of that part of Linkage Group I immediately adjacent to the ad-3 region. A comparison with the genetic map derived from intercrosses of some of the same markers indicates the same order of genes on both maps. The present homology tests provide a more detailed mapping of the ad-3^{IR} mutations and show that many of them cover other known biochemical loci in the immediately adjacent regions. Both ad-3A^{IR} and ad-3B^{IR} mutations can cover a maximum of about 4.3 map units. The longest deletions in this region are a minimum of 8.7 map units. Present data indicate a minimum of four genes with unknown functions in the X region between the ad-3A and ad-3B loci. The map distance of 0.25 map unit for the X region suggests that there is a minimum of 16 genes per map unit. When this calculation is applied to map distances in the regions proximal to the ad-3A locus and distal to the ad-3B locus, this region of Linkage Group I emerges as a vast unknown rather than as the well-mapped region that it might appear to be at first glance. (auth)

31708 GENETIC STUDIES OF UREASE MUTANTS IN NEUROSPORA CRASSA. Koelmark, H. G. (Uppsala Univ.). Mutat. Res., 8: 51-63(July-Aug. 1969).

Urease-defective mutants, genetic symbol ure, from Neurospora crassa were studied genetically with the use of known markers in crosses. A method was developed for rapid testing of urease activity in cultures from ascospore isolations. Two ure mutants, isolation numbers (9) and (47), respectively, were located in the right arm of linkage group V, approximately 30 crossover units from the centromere. The two ure mutants are at separate loci at a distance of approximately 3 c.o. units. They are separated by the gene am. Recombination between the two ure loci was studied using the closely linked markers am$_1$ (32213) and hist-1 (C91). A screening procedure was used to select for rare recombinant types from among random ascospores. A I ure$^+$: 3 ure$^-$ segregation of spore pairs within dissected asci was found in crosses between ure mutants (9) and (47). Mutants from the two ure loci complement to form urease-positive heterokaryons. The urease mutants are designed with a locus and an allele (isolation) number as ure-1 (9) and ure-2 (47), respectively, for future use. The results are discussed in relation to other complex gene–enzyme systems in Neurospora. (auth)

31709 STUDIES ON MUTATIONS INDUCED BY ULTRAVIOLET RADIATION IN PARAMECIUM AURELIA WITH SPECIAL EMPHASIS ON PHOTOREVERSAL. Kimball, R. F. (Oak Ridge National Lab., Tenn.). Mutat. Res., 8: 79-89(July-Aug. 1969).

Studies were made of mutations induced by ultraviolet radiation in Paramecium aurelia. The mutation yield is a maximum when the paramecia are exposed to uv just before or perhaps during the S period and is less the longer the time between irradiation and S. The interpretation is made that uv-induced premutational damage can undergo dark repair until S and that this repair is nearly error-free since the yield when the time to S becomes long enough is nearly zero. About half the mutation yield can be eliminated by photoreversal and arguments are presented that this portion of the mutation yield is attributable to pyrimidine dimers. The remainder of the yield could be due to some other lesion or to dimers that are unavailable to the photoreversing enzyme. Photoreversal becomes ineffective in reducing the mutation yield while the cells are still in G_1. Data are given to show that this is because the nucleus loses the ability to photoreverse even newly produced lesions. This loss in ability to photoreverse lesions is dependent upon prior irradiation; i.e., it does not occur in unirradiated cells progressing normally through G_1. Thus, loss of photoreversibility cannot be used in this system to test for mutation fixation. (auth)

31710 STUDIES ON A RECOMBINATION-DEFICIENT MUTANT OF DROSOPHILA. I. DOMINANT LETHALS. Watson, W. A. F. (Univ. of Aberdeen, Scotland). Mutat. Res., 8: 91-100(July-Aug. 1969).

Dominant lethal studies carried out following irradiation of stage-7 and stage-14 oocytes of the recombination-deficient mutant c3G of Drosophila melanogaster provide strong evidence that it is also more radiation-sensitive than wild-type flies, and that this increased sensitivity is due to a defective repair mechanism normally operative in stage-7 oocytes. The mutant thus appears to be analogous to those found in bacteria and fungi which behave in a similar fashion, and provide evidence of a common basis for repair and recombination mechanisms in higher organisms. (auth)

31711 RADIATION-INDUCED LOSS OF RING-X CHROMOSOMES IN THE GERM CELLS OF DROSOPHILA MELANOGASTER MALES. Leigh, B. (Univ. of Leiden). Mutat. Res., 8: 101-9(July-Aug. 1969).

A comparison was made between the sensitivities of spermatocytes and postmeiotic germ cells, for the induction of XO males and sex-ratio shift. Adult males were irradiated and the treated germ cells were sampled in a brooding scheme. In post-meiotic germ cells there was a uniform sensitivity for the induction of XO males. Within the range of exposures given, the frequencies of XO males increased linearly with increasing exposure. In spermatocytes, which were the most sensitive germ-cell stage for the induction of XO males, the frequencies of XO males increased non-linearly with increasing exposure. Significant sex-ratio shifts were found only when germ cells were sampled on the first six days after irradiation. It was not possible to establish a common relationship between the induction of XO males and sex-ratio shift when post-meiotic germ cells were irradiated. The highest frequencies of XO males were found in the progeny from sperm sampled on the eighth day after irradiation. This was also the period when the fertility of the irradiated males was most reduced. It is suggested that induced crossing-over may be the mechanism which is largely responsible for the production of high frequencies of XO males when spermatocytes are irradiated. (auth)

31712 GENETIC EFFECTS OF TRITIATED THYMIDINE AND EVIDENCE FOR ITS INCORPORATION INTO A CYTOPLASMIC COMPONENT OF THE ADULT TESTIS OF DROSOPHILA MELANOGASTER. Kaplan, William D.; Oftedal, Per (City of Hope Medical Center, Duarte, Calif. Norsk Hydro Inst. for Cancer Research, Oslo). Mutat. Res., 8: 127-38(July-Aug. 1969).

Sex-linked recessive lethals were induced by the injection of [^{3}H] thymidine into male imagos of Drosophila melanogaster. Elevated mutation rates were observed earlier than the tenth day post-injection when the first labeled sperm cells are expected to be available for fertilization. Radioautographs prepared from testes of males taken from successive broods disclosed a cytoplasmic label that was removable by DNAase. It is suggested that radiations from the labeled cytoplasmic DNA were responsible for the mutations produced in the early broods. The nature of the cytoplasmic body which had incorporated the [^{3}H] thymidine is not known. (auth)

31713 FINE STRUCTURE ANALYSIS OF A CHROMOSOME SEGMENT IN DROSOPHILA MELANOGASTER: ANALYSIS OF ETHYL METHANESULPHONATE-INDUCED LETHALS. Lifschytz, Eliezer; Falk, Raphael (Hebrew Univ., Jerusalem). Mutat. Res., 8: 147-55(July-Aug. 1969).

An allelism matrix of ethyl methanesulfonate-induced recessive lethals found in a short chromosomal segment covered by the Y·mal$^+$ chromosome was constructed. When allelism tests for the lethals were extended to x-ray-induced lethals, a consistent linear map of 34 functional units could be constructed. 80% of the chemically induced lethals comprised single sections, which supports the view that most ethyl methanesulfonate-induced lethals were point-mutations. Most x-ray-induced lethals that were multi-section lethals were aberrations. The distribution

of mutations in the affected units was highly non-random; consequently any pooling of sensitivity patterns for whole chromosome segments would be misleading. There were some "hot-spots," possibly due to the vicinity of intercalary heterochromatin. There was also an excess of chromosomes with more than one lethal. The possibility that variation in specificity of lethal and visible mutations obtained with different mutagenic agents is a secondary function of the number of essential sites in vital and non-vital genes is discussed. (auth)

31714 THE PROGRESSIVE APPROXIMATION, WITH STORAGE, OF THE SPECTRUM OF TEM-INDUCED CHROMOSOMAL CHANGES IN DROSOPHILA SPERM TO THAT FOUND AFTER IRRADIATION. Slizynska, H. (Inst. of Animal Genetics, Edinburgh). Mutat. Res., 8: 165-75(July-Aug. 1969).

Structural changes induced by triethylene melamine (TEM) in Drosophila spermatozoa and the effect of storage on the relative frequencies of mosaic and complete changes were studied cytologically. The pattern of TEM-induced structural changes in unstored spermatozoa differs from that induced by x rays by: a higher proportion of mosaics; a higher proportion of repeats and deficiencies and a lower one of translocations and inversions; a lower proportion of inter-chromosomal changes; and a lower proportion of breaks located in heterochromatin. Storing of treated spermatozoa reduced these differences and the whole pattern of changes became more like that found after irradiation. The peculiar pattern of TEM-induced changes has been attributed to a high proportion (almost 100%) of originally latent breaks which tend to open simultaneously in the same chromosome. The frequency of breaks that produced complete changes increased continuously with time of storage, but the frequencies of breaks involved in mosaics seem to have two peaks: one very early during storage and one very late, with a period of low frequency in between. The applicability of the assumption that both mosaic and complete changes are produced by one type of latent break is discussed. (auth)

31715 THE SPLITTING OF HUMAN CHROMOSOMES INTO CHROMATIDS IN THE ABSENCE OF EITHER DNA OR PROTEIN SYNTHESIS. Wolff, Sheldon (Univ. of California Medical Center, San Francisco). Mutat. Res., 8: 207-14(July-Aug. 1969).

If cells are irradiated during most of the G_1 portion of the cell cycle, chromosome aberrations are produced. If, however, they are irradiated while in S or G_2, chromatid aberrations are formed. The best estimate of when the transition occurs is late G_1. That is, in both plant and animal cells, the chromosome splits into chromatids before DNA synthesis. This doubling of the chromosome conceivably could be caused by either a synthesis of chromosomal protein prior to S, or by a loosening of a multistranded structure. Experiments were carried out with phytohemagglutinin-stimulated human lymphocytes to test which of the two possible explanations cited above would be the more likely. Phytohemagglutinin-stimulated lymphocytes were cultured in the presence of $2 \cdot 10^{-3}$ hydroxyurea and tritiated thymidine for 40 hr. The hydroxyurea was used to inhibit DNA synthesis and to enrich the population of cells at the end of G_1. Cells were then irradiated with 200 R of x rays and recultured in the absence of tritium. When the cells reached metaphase, unlabeled cells were scored for the types of aberrations induced by the prior irradiation. Chromatid aberrations were found, indicating that in human cells, too, the split occurs in G_1 in the absence of DNA synthesis. Similar experiments in which the protein synthesis inhibitor cycloheximide was added after the cells were in culture for 16 hr (before any DNA synthesis had occurred) and kept in until the fortieth hour showed that the transition occurred when protein synthesis was inhibited, too. The experiments indicate that the human somatic chromosome is a multistranded structure that loosens in late G_1 to form functional chromatids. (auth)

31716 GENE AND CHROMOSOME MUTATION AFTER LARGE FRACTIONATED OR UNFRACTIONATED RADIATION DOSES TO MOUSE SPERMATOGONIA. Lyon, M. F.; Morris, T. (Medical Research Council, Harwell, Eng.). Mutat. Res., 8: 191-8(July-Aug. 1969).

Previous experiments by Russell had shown that the specific locus mutation rate after a dose of 1000 R x rays to mouse spermatogonia was below that after 600 R, whereas after a fractionated dose of 500 + 500 R 24 hr apart the rate was above that expected by linear extrapolation. In the present experiment, using the same mouse stock ($C_3H \times 101$), the incidences of dominant lethal mutations and of chromosome translocations were shown similarly to decrease with increase of x ray dose from 600 to 1000 rad, though proportionally the decrease in translocations was greater. After a fractionated dose of 500 + 500 rad 24 hr apart the incidence of dominant lethals was enhanced above that expected by linear extrapolation, as were the mutation rates to a new set of specific loci (a, bp, fz, ln, pa, pe) and to dominant visibles. The incidence of translocations was above that after 1000 rad but not above that expected by linear extrapolation. These results are thought to confirm Russell's view that the effects of dose fractionation were due to cell synchronization. It is suggested that the elimination of cells with unstable chromosome aberrations accounts for a large part of the decrease in observed gene and chromosome mutation rates after high radiation doses. (auth)

31717 FREQUENCY PATTERN OF MOSAIC AND WHOLE-BODY MUTANTS INDUCED BY IONIZING RADIATIONS IN POST-MEIOTIC CELLS OF THE MALE SILKWORM. Tazima, Yataro; Onimaru, Kimiharu (National Inst. of Genetics, Misima, Japan). Mutat. Res., 8: 177-90(July-Aug. 1969).

Mutation spectra induced by γ or x rays in postmeiotic germ cells of male silkworm are considered with special regard to the change in frequency pattern of mosaic (fractional) and whole-body (complete) mutants. When silkworm spermatozoa are irradiated with γ rays, the frequency of whole-body mutants increases linearly with increasing dose, whereas that of mosaics increases exponentially. The latter relation is in striking contrast to that observed in Drosophila, where the incidence of mosaics has been known to reach a plateau at a relatively low dose level. Several possibilities are considered for the interpretation of the difference. Mosaics produced after irradiation of silkworm spermatozoa appear to form a mixed class of at least two types, single-helix type and chromosome-aberration type. The proportion of both may vary depending on the irradiated dose. The incidence of mosaics in comparison to that of whole-body mutants varies considerably with the progress of spermatogenesis. On a per R-basis, spermatogonia yield the lowest frequency of mosaics; the frequencies of both complete and mosaic mutations increase sharply through meiotic prophase up to V-4.5 (fifth instar larvae, day 4.5). Until this stage relatively more completes than fractionals are produced. Around V-4.5 the ratio of mosaics to completes reaches unity. From this stage onward, during spermiogenesis, relatively more mosaics than completes are produced, although their absolute frequencies of induction are far lower than in V-4.5. This observation may be interpreted as resulting from a greater capacity for repair of premutational damage leading to mosaic mutations in the early than in the late stages of spermiogenesis. (auth)

31718 CHROMOSOME ANALYSES OF GEMINI ASTRONAUTS. Gooch, P. C.; Berry, C. A. (Oak Ridge National Lab., Tenn. Manned Spacecraft Center, Houston, Tex.). Aerosp. Med., 40: 610-14(June 1969).

Pre- and postflight leukocyte chromosome aberration analyses were carried out on the Gemini astronauts. No large chromosomal effects of spaceflight were demonstrated. The small post-flight increases in aberration levels observed after some of the missions could not be correlated with flight duration, isotope injection, or extra vehicular activity. (auth)

31719 THE MUTABILITY TOWARD ULTRAVIOLET LIGHT OF RECOMBINATION-DEFICIENT STRAINS OF ESCHERICHIA COLI. Witkin, Evelyn M. (State Univ. of New York, Brooklyn). Mutat. Res., 8: 9-14(July-Aug. 1969).

Strains having recA and recC mutations were tested for uv mutability. A recA strain is uv-stable at doses that are demonstrably mutagenic in its Rec+ derivative. Strains of recC genotype are not uv-stable, but produce uv-induced mutations at frequencies significantly lower than those produced at the same doses in Rec+ strains. The results support the hypothesis that most uv-induced mutations originate as errors in recombinational repair of single-strand gaps in DNA. (auth)

Health Physics and Safety

Refer also to abstracts 31327, 31446, and 32949.

31720 (UCRL-50007-68-3) HAZARDS CONTROL PROGRESS REPORT NO. 32 (SEPTEMBER-DECEMBER 1968) AND INDEX TO HAZARDS CONTROL PROGRESS REPORTS NOS. 30 THROUGH 32. (California Univ., Livermore. Lawrence Radiation Lab.). 79p. Dep. CFSTI.

Separate abstracts were prepared for each of the twelve sections presented. (B.G.D.)

For abstracts of individual sections see: 31282, 31283, 31485, 31519, 31520, 31540, 31563-31566, 31598, and 31754.

Radioactive Contamination and Decontamination

Refer also to abstracts 31612, 31631, 31683, 31806, 31809, and 31829.

31721 (AD-683208) RADIOLOGICAL SURVEY OF HAMPTON ROADS, VIRGINIA. Harvey, Hubert D. Jr.; Toerber, Erwin D.;

Gordon, John A. (Southeastern Radiological Health Lab., Montgomery, Ala.). Jan. 1968. 23p. CFSTI.

The ^{60}Co deposition was found to be relatively localized and was not detected in any of the biota or water samples. Therefore, based on the information gathered from this survey, it is concluded that no public health hazard exists in Hampton Roads as of January 1968 as a result of nuclear vessel operation. (auth) (USGRDR)

31722 (CONF-690513-1) DIETARY LEVELS OF ^{90}Sr, ^{137}Cs, AND ^{131}I FOR THE YEARS 1965–68. Final Report, January 1, 1965–February 28, 1969. Wortley, G. (Joint FAO/IAEA Div. of Atomic Energy in Agriculture). Mar. 6, 1969. 30p. Dep.

From 19th Session of UNSCEAR, New York.

Tables are presented to show levels of ^{137}Cs, ^{131}I, and ^{90}Sr in milk, grain products, fruits, vegetables, meats, and total diet in North America, Europe, Asia, Far East, Middle America, South America, Africa, Hawaii and Australia during 1965 to 1968. The trend of ^{137}Cs and ^{90}Sr levels in the total diet during the period 1965 to 1968 was downward with the exception of ^{137}Cs daily intake in France which appeared to show a rise in 1968. The trends of radioisotope levels in various foods during 1965 to 1968 are discussed. Data concerning the daily intake of foods likely to contribute significantly to the intake of fallout radionuclides, such as milk, meat, eggs, vegatables, fruits, and cereals, are discussed. (H.L.W.)

31723 (KFK–810) DETERMINATION OF RADIONUCLIDES IN BIOLOGICAL MATERIAL (T, ^{14}C, Po, U, Pu, Am, Cm, and Cf). Schieferdecker, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Nov. 1968. 91p. (In German). Dep.

For urine, feces, blood, and expired air methods were developed and practically applied for the detection of very small amounts of tritium, carbon-14, polonium, uranium, plutonium, americium, curium, and californium. Based on their biochemical properties, maximal permissible concentrations in the above mentioned biological materials were evaluated for each nuclide; then, the detection procedures were developed and refined to such a degree that at least 10% of the maximal permissible amount could be measured accurately. (H.B.G.)

31724 (KFK–868) THE SPREADING OF A RADIOACTIVE CLOUD AND THE EXPECTED DOSE TO THE TOTAL POPULATION. Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct. 1968. 43p. (In German). Dep.

The assumption is made that an accident occurs in a nuclear installation and that radioactive material in significant amounts is released through the stack. Within a 100 km radius around the nuclear installation the effects of various isotopes, especially those of radioactive iodine, on the population are analyzed in respect to distance and height of stack. (H.B.G.)

31725 (LF–39, pp 207-16) PULMONARY LAVAGE AS A THERAPEUTIC MEASURE FOR REMOVING INHALED ^{95}Zr–^{95}Nb OXIDE FROM THE LUNG. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

A technique for removing inhaled ZrO_2 particles, labeled with ^{95}Zr–^{95}Nb, from Beagle dog lungs is described. Twelve dogs, in four groups of three each, received a 10-minute rhinarium-only exposure. One dog from each group served as a control, and the others each received isotonic saline lavages of one lung at 0, 8, or 16 (and one group on all three) days after exposure. The radioactivity in the recovered solution was determined. The lung and whole-body burdens of each animal were determined by profile scanning and whole-body counting before and after lavage. All dogs were scanned and whole-body counted periodically during the course of the experiment to follow the normal lung clearance pattern. At 30 days post-exposure, the animals were sacrificed and various tissues were radioanalyzed. Profile scanning data showed that at sacrifice the control dogs' initial lung burden had decreased by 5%. The initial lung burden of animals lavaged on the day of exposure was reduced by 12%; the animals lavaged on days 8 or 16 post-exposure showed a reduction in the initial lung burden of 26 and 20%, respectively, while the group lavaged on days 0, 8, and 16 resulted in a 28% reduction of the initial lung burden. At sacrifice >98% of the total radioactivity was in the lungs, attesting to the high degree of insolubility of the aerosol. In addition to the demonstrated efficacy of pulmonary lavage as a means of removing insoluble material from the lungs, there was also an increased clearance of material from the lungs via the bronchial lymph nodes. (auth)

31726 (SWRHL–51-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE FAULTLESS EVENT, JANUARY 19, 1968. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Apr. 1969. 13p. Dep. CFSTI.

A final summary is presented of the pre-shot, shot-day, and post-shot activities for the Faultless Event on January 19, 1968 in Nevada. The pre-shot activities included milk and water sampling, air sampling and dosimetry, establishment of community information centers, education of the public in surrounding areas to possible disturbances, and provision of medical and veterinary services. The event day activities included aerial and ground monitoring, establishment of road blocks, and evacuation of people to beyond the shot-range boundaries. Monitoring and surveillance activities following the event revealed no radioactivity above normal background levels in off-site ground and aerial monitoring systems, and aside from a minor rock fall in a nearby open pit mine, no damage or effects other than ground motion were reported. It was concluded from the data that no detectable radioactive contamination of the off-site area resulted from this event. (E.R.B.)

31727 CONTAMINATION OF POTATOES BY IMMERSION IN ^{90}Sr OR ^{137}Cs SOLUTIONS. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm. Untersuch. Forsch., 135: 126-32(1967). (In German).

The activity uptake during immersion in radioisotope solutions was investigated on potatoes. The effect of the form and the state on the uptake was considered. It was shown that the state of the potatoes can affect the nuclide uptake and that variations exist between the ^{90}Sr and ^{137}Cs nuclides. The transition function was determined and the qualitative pattern of the activity uptake was mathematically formulated. The transition function is a characteristic constant of the product studied and the nuclide used. The absorbability of various products for different radionuclides may be compared by determination of this constant when it is determined by studies with constant parameters. It was shown that a contamination occurring by immersion through the skin of the potato can be removed since the skin contains at least 95% of the activity. (tr-auth)

31728 WHOLE BODY ^{137}Cs AND ITS RELATION TO BODY COMPOSITION AND DIET. Steinkamp, R. C. (California State Dept. of Public Health, Berkeley); Sargent, T. W.; Isaacs, E.; Cohen, N. L.; Hutson, E. M.; Kunkel, N. D. Radiol. Health Data Rep., 9: 619-26(Nov. 1968).

Between September 1962 and July 1963, a time of increasing cesium-137 content in the biosphere, whole-body cesium-137 and potassium-40 measurements were performed in an Argonne-type scintillation counter on 80 subjects; 52 men and 28 women. These data were correlated with body composition estimates of body fat and lean body mass. Seventy-eight were correlated with in vivo cesium-137 measurements. The results suggest that calculations of dose rates for cesium-137 may be more meaningful if based on lean body mass rather than total-body weight as is done presently. Intakes of milk and fruits and vegetables correlated significantly with in vivo cesium-137 measurements for those subjects with extremely low or extremely high food intakes. A regression equation was determined to calculate pCi cesium-137/g potassium in people from pCi cesium-137/g potassium in milk. There appeared to be a time lag of 4 to 5 months between rising values of cesium-137 in milk and those in people, consistent with the biological half-life of cesium-137. (auth)

31729 ASPECTS OF METABOLISM OF STRONTIUM, CESIUM, AND IODINE ISOTOPES IN ANIMALS. Baditoiu, I.; Cavulea, O.; Jucu, V. Rev. Sanit. Mil., 71: 951-6(Nov.-Dec. 1968). (In Rumanian).

Aspects of radioactive isotope metabolism in tissues of various animals were analyzed. Tabulated data are given on permissible concentration and incorporation of radio nuclides (^{131}I, ^{89}Sr, ^{90}Sr, and ^{137}Cs). (R.V.J.)

31730 EVOLUTION OF SOME WASHING AGENTS AS DECONTAMINANTS OF THE SKIN CONTAMINATED WITH ^{137}Cs. Gajewski, A.; Grzymala, W.; Majle, T.; Ziabicka, L. (State Inst. of Hygiene, Warsaw). Pol. Tech. J., 11: 1311-14(1967). (In Polish).

Water, two solutions Block type, one solution Nosak type and six commercial detergents were used for decontamination of the skin contaminated with ^{137}Cs. The experiment showed that the commercial detergents are as good as solutions used by Block and Nosek. It was also shown that the rate of decontamination is better when the process is carried out 30 min after the contamination than 3 hrs after contamination. (auth) (NSA of Poland)

31731 DISTRIBUTION OF NATURALLY OCCURRING RADIONUCLIDES BELONGING TO URANIUM DECAY SERIES. 3. ^{210}Po, ^{226}Ra, AND URANIUM CONTENTS IN THE HUMAN URINE. Kuroda, T. Igaku To Seibutsugaku, 75: 234-6(Dec. 10, 1967). (In Japanese).

Urine samples were collected over 24 to 48 hours and subjected to wet ashing with nitric acid. The nitric acid was removed by

perchloric acid treatment, and the residue from this treatment was dissolved in 0.5N HCl. Polonium-210 was separated from this solution, and the remaining solution was divided into two parts for the ^{226}Ra and uranium assay. Uranium was determined by reflectance fluorimetry. The recovery of Po was 94 ± 16% as indicated by spikes. Residents of Miasa (Tottori Prefecture) showed higher Po and U content in their urine than residents of Okayama City. The urine of uranium-mine workers had a higher Po, Ra, and U content than office workers at the same site. Similar data reported in the world literature were listed for comparison. (TTT)

31732 THE DISTRIBUTION OF INHALED ^{239}Pu DIOXIDE PARTICLES WITHIN PULMONARY MACROPHAGES. Sanders, Charles L. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Arch. Environ. Health, 18: 904-12(June 1969).

Pulmonary macrophages and radioactive plutonium dioxide particles were removed from the lungs of rats by lung washing following inhalation of $^{239}PuO_2$ particles. Plutonium particles were rapidly phagocytized and retained within pulmonary macrophages for extended periods of time. Phagocytic indexes correlated well with the log ^{239}Pu content of the lung from one hour to 25 days after exposure. As much as half of lung-deposited plutonium could be removed from the lung by serial saline washing, the amount depending on the amount of plutonium inhaled and the time since inhalation. The greater the amount of plutonium in the lung, the earlier and more severe were the pathological alterations, resulting in less effective removal by lung washing. The removal of inhaled radioactive particles by lung washing is a useful experimental technique and may be of therapeutic value. (auth)

31733 ASSAY OF ^{90}Sr IN HUMAN PERMANENT TEETH IN THE UNITED KINGDOM 1963–1965. Starkey, W. E. (Royal Naval Medical School, Gosport, Eng.); Goodridge, D. L.; Fletcher, W.; Brooks, W. L. J. Roy. Nav. Med. Serv. (London), 54: No. 3, 1-6(Winter 1968).

A survey was made of ^{90}Sr in human permanent teeth in the United Kingdom from 1963 to 1965. The ^{90}Sr concentration rose with the passage of time in all age groups studied. It was higher in the younger than in the older groups, and higher in the roots than in the crowns of teeth. Samples from heavy rainfall areas had higher values than corresponding samples. (F.M.M.)

31734 RADIOIODINE IN THE BIOSPHERE DURING 1968. Van Middlesworth, L. (Univ. of Tennessee, Memphis). Nature (London), 221: 1041-2(Mar. 15, 1969).

Most of the ^{131}I contamination in the northern and southern hemispheres during 1968 was correlated with announced tests of nuclear weapons in the atmosphere, but some of the ^{131}I present has not been accounted for. Data derived from the thyroids of animals slaughtered in Tennessee and in Australia have given a sensitive index of maximum biological contamination in the northern and southern hemispheres, and details are given of such studies. After the contamination during July and August maximum values were attained in the southern hemisphere 6 to 7 weeks sooner than in the northern hemisphere. The contamination in late August 1968 was probably associated with a suspected thermonuclear release in the South Pacific Ocean, and the radioactivity released during August and September in the southern hemisphere was probably the source of the increased ^{131}I in Tennessee and England during October. The least accumulation of ^{131}I was in Japanese cattle, and the highest accumulations in sheep from Australia in the south and England in the north. Smaller increases of ^{131}I contamination were observed during May, June, and July, and these remain unexplained; they might be related to leaks from nuclear reactors or to atmospheric leaks from underground nuclear weapons tests. The data reported clearly indicate that the biosphere has been contaminated almost continuously with releases of ^{131}I. The average accumulated dose of ^{131}I radiation to the thyroids of grazing sheep in Australia was 0.17 R equivalents during August and up to the end of November 1968, representing the highest contamination observed during 1968. (UK)

31735 REMOVAL OF INHALED ^{144}Ce–^{144}Pr OXIDE BY DIETHYLENETRIAMINEPENTAACETIC ACID (DTPA) TREATMENT. I. ^{144}Ce–^{144}Pr OXIDE PREPARED BY PEROXIDE OXIDATION. Tombropoulos, E. G.; Bair, W. J.; Park, J. F. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 16: 333-8(Mar. 1969).

Therapy with DTPA was beneficial in removing inhaled ^{144}Ce–^{144}Pr oxide from dogs; the effectiveness of the treatment depended upon the promptness with which it was initiated. In dogs given DTPA immediately after inhalation of ^{144}Ce–^{144}Pr oxide, the body burden was reduced by 90% within 30 days, compared to only about a 30% reduction in the untreated controls. Treatment initiated even as long as 90 days after exposure to ^{144}Ce–^{144}Pr oxide increased the clearance of ^{144}Ce–^{144}Pr from the body, but the effect was small in comparison to that obtained by earlier treatments. Deposition of ^{144}Ce–^{144}Pr in the skeleton was not reduced to any appreciable extent when administration of DTPA was delayed. The method of preparation of the oxide is described. (auth)(UK)

31736 ALPHA-RAY ACTIVITY IN THE LARGE HUMAN ARTERIES. Elkeles, A. (Prince of Wales General Hospital, London). Nature (London), 221: 662-4(Feb. 15, 1969).

Histochemical studies have shown that deposits of Ca in human aortas and coronary arteries steadily increase with age. Radioactivity tends to follow Ca deposition, and this was thought to give a method of studying Ca deposition. Correlation between ash content and alpha activity was examined for many abdominal aortas, coronary and pulmonary arteries, and for comparison ventral costal cartilages and femoral bones, with an age range of 20 to 87 years. Results are shown graphically and discussed. The correlation in abdominal aortas was statistically significant, and still more so in coronary arteries, particularly in cases of death from coronary heart disease. No correlation was found for pulmonary arteries, or for ventral costal cartilages. (UK)

31737 NATURAL AND ARTIFICIAL RADIONUCLIDES IN SEAFOODS AND MARINE PROTEIN CONCENTRATES. Beasley, Thomas M. (Oregon State Univ., Corvallis); Osterberg, Charles L.; Jones, Yvonne M. Nature (London), 221: 1207-9(Mar. 29, 1969).

The concentrations of various radionuclides in seafoods were measured, and the results indicate that if marine protein concentrates are used as human food the ^{210}Pb–^{210}Po pair may become the principal source of the skeletal radiation dose. (auth)(UK)

31738 MEASUREMENT OF THORON IN THE BREATH OF THOROTRAST SUBJECTS. Tai-pow, J. (Ontario Dept. of Health, Toronto). Health Phys., 16: 269-75(Mar. 1969).

An apparatus is described for the measurement of thoron, ^{220}Rn, in the breath of thorotrast (colloidal thorium oxide) subjects. The simplicity, portability, stability and low resistance to breathing of the system is a great advantage in analyzing the breath of subjects who are in very poor health and who are confined to their homes. Sixteen subjects in all were measured, seven who had received thorotrast for arteriograms and nine for myelograms. Their body burdens of ^{232}Th varied from 0.03 g to 5.9 g. The thoron activity exhaled per minute was, on the average, 3% of the ^{232}Th activity in the body. The exhaled breath of the subjects was passed through a copper cylinder coated internally with ZnS and viewed by a 2 in. diameter photomultiplier. (auth)(UK)

31739 DEPOSITION OF DRY AEROSOLS ON SOME CULTIVATED PLANTS. Belot, Y.; Caput, C.; Quinault, J.-M. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Radioprotection, 3: 293-304(1968). (In French).

The deposition of a dry aerosol on alfalfa and wheat crops in a test field was measured under meteorological conditions which represented an average situation. Uranine particles were emitted continuously from a point source during an allotted time. Then the field was sampled in order to measure the flux deposited on the plants, the flux deposited in the Petri dishes used as references and the air concentration. Sampling was made within small homogeneous plots scattered over the test field. The results were analyzed statistically and the deposition velocity estimated within each small sampling plot. Then, the best estimation of the deposition velocity was computed by the weighed least square method for each crop taken as a whole. This velocity was found to equal 0.7 $cm \cdot s^{-1}$ for wheat ears (yield 0.5 $kg \cdot m^{-2}$) and 3.3 $cm \cdot s^{-1}$ for alfalfa (yield 1 $kg \cdot m^{-2}$), the particles ranging from 1 to 10 μ. The deposition on alfalfa was 5 times as much as the reference deposit in the Petri dishes; the deposition on wheat ears was of the same magnitude as the reference deposit. (auth)

31740 SOURCES OF CALCIUM IN THE CHILEAN DIET AND THEIR BEARING ON THE DOSE OF ^{90}Sr RECEIVED BY THE ORGANISM. Valderas, Ramon; Rosales, Eliana (Univ. de Chile, Santiago). Bol. Ofic. Sanit. Panamer., 63: 281-8(Oct. 1967). (In Spanish).

Recently, as a result of a radioactive fallout from nuclear explosions, the study of food contamination has aroused increasing interest in Chile. ^{90}Si is introduced into the organism with the ingestion of foods with a calcium content. The metabolism of ^{90}Sr and calcium are identical and the amount of calcium present provides a realistic index of the dose of ^{90}Sr present in the human body. It is clear that the principal source of calcium in the Chilean diet is milk, which provides 393 mg per day. This is followed by cereals with 197 mg per day and then, in order of importance, by legumes, meat, potatoes, and fruit. An inquiry into the contamination of the human organism by ^{90}Sr should include, in addition to the

products already mentioned, flour and bread which represent 93% of the consumption of cereals in the country. Statistics indicate that the average per capita ingestion of calcium is similar to that of European countries: between 700 and 720 mg per day. A large percentage of this intake is attributable to carbohydrates which form an important part of the Chilean Diet. Fish are only a minor source of ^{90}Sr and calcium in the Chilean diet. The results of the presence of ^{90}Sr in foods are such as to make it desirable to undertake an inquiry into a particular food obtained from a number of different latitudes. (auth)

31741 PULMONARY LAVAGE AS A THERAPEUTIC MEASURE FOR REMOVING INHALED "INSOLUBLE" MATERIALS FROM THE LUNG. Pfleger, R. C.; Wilson, A. J.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Health Phys., 16: 758-63(June 1969).

The successful use of pulmonary lavage as a post-inhalation therapeutic measure in reducing the retained lung burden of an insoluble form of ^{137}Cs in beagle dogs is reported. (auth) (UK)

31742 RADIOLOGICAL PROTECTION OF THE PUBLIC IN LARGE-SCALE NUCLEAR EMERGENCIES. Becker, K. (Oak Ridge National Lab., Tenn.). Health Phys., 16: 788-90(June 1969).

A summary is given of the papers presented at the 1968 annual meeting of the German-Swiss "Fachverband fuer Strahlenschutz," which represents the health physicists in those countries, and is a charter member of the International Radiation Protection Association. The subject was major problems related to survival during, and recovery from, large scale contamination by fallout due to either accidental or deliberate nuclear explosions at ground level. Topics covered included: Characteristics of and hazards from local fallout; what to measure, and why and how; interpretation of measurements; protective and technical counter-measures; decision-making; survival and recovery. (UK)

31743 THE BIOLOGICAL EXCRETION PATTERN FROM A PERSON INVOLVED IN THE INHALATION OF A MIXTURE OF ENRICHED URANIUM OXIDE AND LEAD METAL POWDERS. Bains, M. E. D.; Rowbury, P. W. J. (Atomic Energy Establishment, Winfrith, Eng.). Health Phys., 16: 449-53(Apr. 1969).

A worker inhaled a significant amount of enriched uranium oxide during a pellet processing operation. The results of personal air sampling measurements taken during the whole of the operation are given. Measurements were also made of the enriched uranium which was excreted in urine and fecal samples which had been collected at intervals for 32 months following the operation. An estimate of total uranium intake was made by three independent methods. (auth)

31744 DISPOSAL OF RADIOACTIVE WASTES FROM U.S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES, 1967. Miles, M. E.; Mangeno, J. J. (Dept. of the Navy, Washington, D. C.). Radiol. Health Data Rep., 10: 135-8 (Apr. 1969).

Data on the disposal of radioactive wastes from U.S. Naval nuclear-powered ships and their support facilities are presented in tabular form, and the results of environmental monitoring performed to confirm the adequacy of waste disposal limits and procedures are summarized. The data include total γ radioactivity discharged as liquid wastes into various harbors during 1963 through 1967, total γ radioactivity and volume of solid radioactive wastes disposed of during 1963 through 1967, and the ^{60}Co content of bottom sediments in U.S. harbors during 1967 where nuclear-powered ships are regularly based, overhauled, or built. (E.R.B.)

31745 EFFICIENCY OF AN ION-EXCHANGER IN THE REMOVAL OF RADIOACTIVE SUBSTANCES IN RAT DIGESTIVE TRACT. Bergheanu, S.; Gheorghe, N.; Plesca, I. Oncol. Radiol., 6: 431-4(1967). (In Rumanian).

The efficiency of an ion exchange material in removal of radioactive substances from the digestive tract was studied in 80 albino rats. Half an hour following the oral administration of ^{131}I (10 μCi) a small amount was adsorbed on the ion exchange material. Examination of the intestinal mucosa over the next 72 hr showed that only a small amount of the ^{131}I had been absorbed. (R.V.J.)

Dosimetry and Monitoring

Refer also to abstracts 31304, 31519, 31604, 31605, 31630, 31682, 31721, 31723, 31738, 31812, 31829, 31981, and 32888.

31746 (ANL-Trans-749) HISTORY OF AN INTERNAL CONTAMINATION BY RADIUM. Delpla, M.; Schaeffer, R. Translated by William Sluis (Argonne National Lab., Ill.), from 10th National Conference on Industrial Medicine, Grenoble, France, September 14, 1968. 19p. (CONF-680952-2). Dep. CFSTI.

A woman, who was contaminated by ^{226}Ra at the age of 48 yrs, for therapeutic purposes, has lived to 84 yrs. Her skeleton charge, (10.5 μCi) is one of the highest known. Notwithstanding the gaps in our observation, it was possible to deduce that, according to the most probable hypothesis, her blood must have received about 30 μCi per week for a period of about ten months, and that the maximum skeleton charge (about 80 μCi) gave, in the high radium concentration zones, a dose equivalent accumulation of nearly 2,000 rems per day, and in 36 years, more than 5,000,000 rems. And this woman still did not die from cancer! (auth)

31747 (CEX-65.13) DISTRIBUTION OF RADIATION FROM A 14-MeV NEUTRON SOURCE IN AND NEAR STRUCTURES. Cheka, J. S. (Oak Ridge National Lab., Tenn.). Nov. 1968. 33p. Dep. CFSTI.

The angular distribution of radiation in radiation-equivalent Japanese housing was determined. The radiation source was a 14 MeV neutron generator that utilized the $^{3}H(d,n)^{4}He$ reaction with the design capability of 500 mA of beam current and a neutron output of $\sim 10^{13}$ n/sec over a 4-hr period; it was mounted on a hoist car on a 1500 ft tower and could be positioned at elevations from 25 to 1500 ft. Measurements were made in the house with pairs of one Radsan and one GM tube on racks 3 and 5 ft above selected points. Standardization and calibration procedures are described. Measurements of both neutron and γ-ray intensity were made at selected points in the house and also at points 4 ft in front of and 4 and 14 ft behind the house with the source elevation at 1125 and 500 ft. Data are presented in graphic and tabular form. (C.O.)

31748 (CONF-681032-, pp 277-84) DOSIMETRY OF ^{252}Cf. Fairchild, R. G. (Brookhaven National Lab., Upton, N. Y.).

In order to evaluate the effects of radiation on biological material, the absorbed dose to tissue must be measured. In this respect, ^{252}Cf presents a more difficult problem than conventional x rays or ^{60}Co irradiators, since it delivers a mixed field of radiation: about 37% of the absorbed dose to tissues is from γ rays, and 63% from fast neutrons. Since the biological response is different for each type of radiation, the absorbed dose from neutrons and γ rays must be measured separately. (auth)

31749 (N-69-19054) COMPARATIVE EVALUATION OF THE RADIATION ENVIRONMENT IN THE BIOSPHERE AND IN SPACE. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Dec. 13, 1968. 23p. (NASA-CR-100031; NAMI-1054). CFSTI.

The radiation environment of the biosphere and that of the outer space were compared in order to arrive at a maximum dose rate for manned space operations. Radiation levels in the biosphere range from lowest levels of 6 microrem/hr over the ocean to more than 300 times higher in areas of Brazil and India. These high levels overlap the lowest in space as long as only regions outside the radiation belt and conditions of a Quiet Sun are considered. By building shelters of indigenous rock on the moon or planets for solar proton storm protection, man's long term survival appears to be assured as related to ionizing radiation. Inconspicuous chronic damage, such as shortening the life span, resulting from galactic radiation exposure in space is difficult to assess quantitatively, although data on this subject have been extrapolated using mice exposed to γ rays and neutrons. As related to acute effects from trapped or flare-produced protons, the greatest operational problem is treatment and alleviation of discomfort from skin erythema, and possibly more severe skin damage, resulting from medium high doses which would leave more deeply seated organs and tissues intact because of the lower depth doses of this type of radiation. (STAR)

31750 (N-69-20924) MEASUREMENT OF ABSORBED RADIATION DOSES DURING FLIGHTS OF SPACE VEHICLES. Makhmudov, B. M. Translated from Vestn. Mosk. Univ., Ser. III. Fiz. Astron., 23: No. 2, 11-16(1968). 8p. (NASA-TT-F-12162). CFSTI.

Radiation doses are given that were received by the astronauts: Gagarin, Titov, Nikolayev, Popovich, Schirra, Cooper, Bykovskiy, Tereskhova, Yegorov, Feoktistov, Komarov, Leonov, and Belyayev during their space flights. The results suggest an absence of radiation hazards for manned space flights at altitudes from 200 to 400 km and an absence of intense chromospheric bursts. Extrapolated daily radiation doses incident in space vehicle cabins are given for flight altitudes up to 2000 km. (STAR)

31751 (NP-17848) NEUTRON DOSIMETRY BY THE METHOD OF ETCHED FISSION TRACKS IN PLASTIC FOILS. ROUTINE INSERTIONS FOR PERSONAL DOSIMETRY IN THE EIR. Radiation Protection Memorandum No. 4. Pretre, S. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug. 8, 1968. 9p. (In German). (TM-SU-101). Dep.

Described are neutron measurements by a personnel dosimeter

recording fission tracks in plastic. The device is inexpensive, lightweight, easy to evaluate, and shows no fading. Neutrons are detected by a foil of natural thorium in contact with a plastic plate; for thermal neutrons, a foil of an alloy containing 1% uranium and 99% aluminum; the uranium is 90% enriched ^{235}U. In routine surveillance, the plastic is etched once a year in potassium hydroxide and the number of tracks is counted under a light microscope. Time of etching, sensitivity, and dose ranges are described. Special procedures, applicable in the case of a nuclear incident, are also briefly discussed. (H.B.G.)

31752 (NRC-TT-1355) DOSIMETRIC CHARACTERISTICS OF INCORPORATED MESOTHORIUM-228: CALCULATION MODEL AND REFERENCE CURVES. Malykhin, V. M.; Shamov, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated by H. R. Hayes (National Research Council of Canada, Ottawa), from report NP-17202. 22p. Dep.

A complete method for analytically and numerically determining the dosimetric characteristics of mesothorium-228 (^{228}Ac) → radiothorium-228 (^{228}Th) is given. The method for determining the accumulation and retention levels of ^{228}Ac and ^{228}Th after a limited uptake period at a constant average daily uptake, the dynamics of removal with excreta, and the accumulation of biological dose are described. Discussions of the following related subjects are included in the report: the mathematical basis for determining the dosimetric characteristics of the ^{228}Ac → ^{228}Th link; the quantitative characterization of the accumulation-retention and excretion levels of ^{228}Ac decay products and the local tissue irradiation dose for different uptake periods; the parameters and general characteristics of the indirect method for tissue dosimetry of ^{228}Ac and the time of possible detection of these or other uptakes of ^{228}Ac in an organism; a method for establishing the size of the dose received in the past during an uptake of ^{228}Ac and during the combined uptake of ^{226}Ra and ^{228}Ac; the comparative characteristics of dosimetric methods for analyzing incorporated ^{228}Ac; and the maximum permissible single uptake and maximum permissible concentration of ^{228}Ac for a limited period of contact. (E.R.B.)

31753 (ORNL-tr-1555) FUNDAMENTAL RELATIONS BETWEEN TRANSFER OF ENERGY PER UNIT OF LENGTH, ABSORBED DOSE, KERMA, AND EXPOSURE. APPLICATION TO CHANGES OF MEDIUM. Joffre, Henri; Pages, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by F. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report CEA-R-3424. 39p. Dep. CFSTI.

After briefly defining the quantities used in dosimetry and presenting them with a view to their simple adaptation to health physics problems, simple mathematical relationships are established to express the absorbed dose, kerma, and exposure in the case of electrons and photons, and also relationships between these various quantities considered in air. The variations in these quantities at the interface between the air and the soft tissues of the organism and in depth in the tissues are studied. Numerical values of the discontinuities liable to appear at the interface are given, and the values obtained, relative to air, after electronic equilibrium is established in depth in the tissues are presented. An example of application to dosimetry is also given in the case of an aluminum-walled ionization chamber. Also, the conditions to be fulfilled in order to make a direct measurement of the absorbed dose in the tissues are presented and discussed. (auth)

31754 (UCRL-50007-68-3, pp 5-11) DOSE RATES FROM A GAMMA-EXCITED FLUORESCENT X-RAY SOURCE. Tinney, J. F.; Boggs, J. V. (California Univ., Livermore. Lawrence Radiation Lab.).

A gamma-excited fluorescent x-ray source is described. Theoretical calculations illustrate the range of dose rates that can be obtained with a back diffusion geometry. Results of dose-rate and relativity measurements for target materials Z = 22 to Z = 69 are also presented. (B.G.D.)

31755 IMPROVED RADON DAUGHTER MONITORING PROCEDURE. Rolle, R. (Environmental Sciences Lab., Johannesburg). Amer. Ind. Hyg. Ass. J., 30: 153-60(Mar.-Apr. 1969).

A simple, rapid procedure for monitoring ^{222}Rn daughters (^{218}Po, ^{214}Pb, and ^{214}Bi) in mine air was developed. Air is drawn through a membrane filter for a period, the duration of which is adjusted to the minimum sampling time necessary to give a specified accuracy in the final results. A single alpha activity measurement of the filter is then made after a decay time of less than 10 minutes. Division of the measured α disintegrations per minute by the volume sampled and by a factor of 200 gives the Working Level directly. The accuracy of this procedure is good and results are obtained without the delay required by other procedures. (auth)

31756 RADIATION DOSE FROM NONEXCHANGEABLE TRITIUM IN RATS AFTER TRITIUM OXIDE INGESTION. Patzer, Robert George. Ann Arbor, Mich., Univ. of Michigan, 1968. 106p.

Thesis.

The radiation dose was determined for tritium which becomes semi-permanently bound to tissue of rats exposed to tritium oxide. Nonexchangeable tritium was defined as that tritium not removed from rat tissue in a series of freeze-dryings and rehydrations with non-tritiated water. A dose commitment was defined as the integral radiation dose in rads from ingested tritium oxide to a time when essentially all tritium was excreted from the rats. The dose commitment from nonexchangeable tritium was compared to that calculated from assuming that tritium was present only in body water. A mathematical model was formulated to describe nonexchangeable tritium concentrations in rat tissue as a function of time and of the tritium oxide concentration in body water. Parameters for the model were determined from tissues of rats which ingested tritium oxide in drinking water. Parameters were determined for nine tissues and for cell nuclei from four of these tissues. Tritium concentrations in samples were determined by liquid scintillation counting. The model was used to calculate concentrations and dose commitments for nonexchangeable tritium and tritium oxide in rats which ingested tritium oxide. The results indicate that for a given tritium oxide intake there is an upper limit to the concentration of nonexchangeable tritium which may be attained in dry tissue. This concentration limit was expressed as a fraction of the tritium oxide concentration in body water; the highest value (0.28) was calculated for brain. For a given tritium oxide intake, whether acute or chronic, the dose commitment for nonexchangeable tritium in a tissue is a constant fraction of the dose commitment for tritium in body water; the highest fraction (0.21) was calculated for sperm, liver nuclei, and small intestine nuclei. Because of the large fraction by weight of water in testes, however, the dose commitment calculated for testes was higher than for other tissues investigated. The applicability of the model and results to other mammals are discussed. The values calculated for dose commitments in this study do not warrant any change in the maximum tritium oxide intake by man recommended by the International Commission on Radiological Protection. (Disser. Abstr.)

31757 RAPID MONITORING PROCEDURE FOR ^{14}C IN BREATH. Doremus, K. R.; O'Brien, M. G.; Gerber, A. M.; Reich, A. (Merck and Co., Inc., Rahway, N. J.). Amer. Ind. Hyg. Ass. J., 30: 161-4(Mar.-Apr. 1969).

A convenient and rapid method for quantitative or semi-quantitative measurement of ^{14}C in breath samples is described. The method is specific and fulfills AEC requirements. Plastic bags are used to obtain and store breath samples. The ^{14}C as $^{14}CO_2$ is absorbed in phenethylamine (PHEA) solution. A toluene phosphor is added to the amine complex and this solution is counted in a scintillation spectrometer. (auth)

31758 DESIGN AND DEVELOPMENT OF A MOBILE IN VIVO RADIATION MONITORING LABORATORY. Scott, L. M.; Abele, H. M.; Bryant, E. H.; Cromwell, H. H.; West, C. M. (Y-12 Plant, Oak Ridge, Tenn.). Amer. Ind. Hyg. Ass. J., 30: 165-9(Mar.-Apr. 1969).

For a large number of radioisotopes, in vivo radiation monitoring techniques are superior to excretion analyses for the estimation of internal exposure. Because of the cost, it is not practical for all plants to have on site in vivo monitoring facilities; therefore, a mobile in vivo radiation monitoring laboratory having a whole-body scintillation counter was developed. It is calibrated for enriched, normal, and depleted uranium, thorium, cesium, and potassium. The sensitivity of this system for uranium and thorium is 40% and 20%, respectively, of a maximum permissible lung burden. Utilizing the computer-multichannel analyzer, a complete estimate of body burden is calculated on site and is available before the subject leaves the shielded room. (auth)

31759 FORMULA FOR THE VARIATION IN X-RAY DEPTH DOSE WITH FOCAL DISTANCE. Jackson, W. (Regional Dept. of Clinical Physics and Bio-engineering, Glasgow). Brit. J. Radiol., 42: 231(Mar. 1969).

A formula is presented for use in calculating the dose of γ or x radiation at various depths in tissues as a function of the focal distance of the radiation beam. (C.H.)

31760 EVALUATION OF EXPERIMENTAL IRRADIATION FRACTIONATION WITH THE SINGLE-HIT, MULTI-TARGET MODEL. Spring, Erik; Holmberg, Peter (University Central Hospital, Helsinki. Univ. of Helsinki). Acta Radiol., Ther., Phys., Biol., 7: 297-306(Aug. 1968).

The experimental results of Fowler (1965) of the change in the total dose with an increasing number of irradiations of cells were compared with theoretical calculations based upon the single-hit, multi-target model. (auth)

31761 THE RADIATION DOSE-RATES NEAR BONE SURFACES IN RABBITS AFTER INTRAVENOUS OR INTRAMUSCULAR INJECTION OF ^{238}Pu. Bleaney, Betty (Churchill Hospital, Oxford). Brit. J. Radiol., 42: 51-6(Jan. 1969).

When intravenous injections of plutonium nitrate are given to seven-month-old rabbits, the plutonium deposited on or near the trabecular bone surfaces remains for up to one year after injection. For intramuscular injections the amount of plutonium near the bone surfaces is about one quarter of that to be expected for an intravenous injection of the same value in μCi/kg after eight days, and half of the corresponding value for intravenous injection after 112 days. The dose-rates for intravenous injections remain remarkably constant at times up to one year after injection, with maximum values 10 μ from the bone surfaces of about 23 rads/day. For intramuscular injections, the dose-rates appear to pass through a maximum at about 112 days after injection and then to decrease. These results suggest that when plutonium is introduced into a muscle through a cut in the skin, a significant amount can be found on the bone surfaces eight days later, and an increasing amount over times up to one year later. (auth)

31762 INFLUENCE OF CONTRASTMEDIA AND ORTHOPEDIC NAILS ON THE DOSE DISTRIBUTION IN TELECOBALT- AND TELECESIUM THERAPY. Debois, Jean-M. (University Hospital, Louvain, Belg.). J. Belge Radiol., 51: 363-5(1968).

The isodose distortion by barium, lipiodol, and Kirschner nails during telecesium and telecobalt therapy is measured. The results are discussed. (TSS) (auth)

31763 MODULATION TRANSFER FUNCTION OF THE INTENSITY DISTRIBUTION OF THE ROENTGEN FOCAL SPOT. Takenaka, Eiichi; Kinoshita, Kojiro; Nakajima, Rokuhiko (Tokyo Univ. Japan Broadcasting Corp., Tokyo). Acta Radiol., Ther., Phys., Biol., 7: 263-72(Aug. 1968).

The intensity distribution of the R focal spot is expanded to symmetry and antisymmetry components on a base of rectangular function. The parameters of its distribution are standardized by its modulation transfer function and relative cut-off frequency. The parameters should be determined by the decrement of relative cut-off frequency. The asymmetric focus has an asymmetric modulation transfer function with a shifted origin. (auth)

31764 CONTRIBUTION TO THE QUANTITATIVE EVALUATION OF THE DISTRIBUTION OF RADIOACTIVE SUBSTANCES IN THE LUNG. Cellerino, A.; Catolla Cavalcanti, R.; Gaetini, A.; Boario, U. (Univ., Turin). Radiol. Med., 54: 704-15 (July 1968). (In Italian).

The intrapulmonary distribution of radioactive insoluble substances can be checked from outside the thorax by many monitoring procedures. However from the physiopathological, clinical point of view it would be useful to have a quantitative estimation of the spread substance, especially when introduced into the pulmonary circulation. The quantitative measurement of the regional distribution of the capillary blood flow starting from the intravenous administration of MAA-^{131}I can be obtained only through the correction of the experimental values for some variable factors: thickness of the thoracic wall, length and height of the pulmonary compartment. A series of measurements on a lung model made of a plastic tissue-equivalent compound was performed. The obtained isocount curves may be utilized for calculating the absolute counting value within each half of any lung compartment. The validity of the method is discussed. (C.O.)

31765 GALACTIC RADIATION EXPOSURE IN FREE INTERPLANETARY SPACE. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Biophysik, 5: 315-26 (1969). (In German).

For manned space flights of the future, which might extend over months or years, not only acute radiation hazards to the astronaut from solar protons or from trapped protons and electrons in the radiation belt, but also chronic effects from the normal galactic radiation have to be considered. Galactic radiation in interplanetary space is anticorrelated to solar activity. It is highest at solar minimum because the deflecting effect of turbulent magnetic fields created by the solar hydrogen plasma is missing. In first approximation, the galactic radiation level can be established from the altitude profile of the total ionization in the atmosphere. However, this estimate does not allow conclusions as to the linear energy transfer (LET) of the various primary and secondary components. Merely the components of the primary radiation are well investigated with regard to their respective energy spectra and their share in the total ionization can be assessed accurately. An LET analysis of the secondary radiation is more difficult. Since the bulk of the primary radiation is made up of particles of extremely high energy, meson production is the predominant factor in the build-up of secondary radiation. Knowledge on interaction cross sections and other parameters is incomplete. This is especially unfortunate with regard to the neutron component because of the Quality Factor of 10 for conversion from absolute doses to dose equivalents. A conservative estimate leads, for hemispherical incidence (2-pi geometry), to an absorbed dose of 40 millirad/24 hr and a dose equivalent of 124 millirem/24 hr at solar minimum. This estimate does not consider the so-called microbeam effects of heavy nuclei reaching the Bragg Peak in tissue. Their contribution to the total dose equivalent is entered merely summarily by using a QF of 20. Little is known on the effectiveness of microbeam irradiation for late damage from medium and low protracted exposures. Agreement seems to exist only on the negative statement that normal dosimetric concepts and units are not applicable to this type of radiation exposure. Disregarding the basically unexplained phenomenon of microbeams one arrives, from a conservative transfer of animal data with neutrons and x or γ rays to man, at an abbreviation of life time of about 25% of the total exposure time for the highest galactic radiation level. (auth)

31766 SKIN EXPOSURE FROM HANDLING SYRINGES CONTAINING RADIOACTIVE ISOTOPES. Clayton, R. S.; White, J. E.; Brieden, M.; Rodriguez, A. (Hotel Dieu Hospital, El Paso, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 897-9(Apr. 1969).

Exposure to the skin of fingers holding syringes containing diagnostic dosages of radioactive isotopes has been measured for one set of circumstances. Obviously, exposure under other circumstances may be higher or lower. Simple measures to minimize exposure are described. All personnel handling radioisotopes under similar circumstances should be encouraged to practice techniques which will minimize exposure to the skin as well as to the entire body. (auth)

31767 DOSE IN LIVER AND SPLEEN AFTER INJECTION OF THOROTRAST INTO BLOOD. Kaul, A. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Isotopenpraxis, 5: 85-94(Mar. 1969).

The calculation of the dose-rate and cumulative dose in the liver and spleen of Thorotrast patients as function of time after Thorotrast incorporation presupposes the knowledge of both the distribution of ^{232}Th and its daughters in the organism, and the activity ratios between the thorium decay products due to translocation and excretion from the body. A comprehensive study on distribution and excretion in a larger number of Thorotrast patients is presented and compared to studies previously published. Considering the measured activity ratios between ^{232}Th and its daughters as well as the agglomeration of the ThO_2-particles within the RES and self-absorption of α-particles within the aggregates, the dose-rate and cumulative radiation dose in the liver and spleen were calculated as function of time of Thorotrast burden and the amount of injected material. (auth)

31768 RIB FRACTURE BY THE POSTOPERATIVE IRRADIATION OF BREAST CANCER: THE RELATIONSHIP BETWEEN RIB FRACTURE AND DOSE DISTRIBUTION. Kakehi, Hirotake; Toyama, Tomiya; Arimizu, Noboru; Tateno, Yukio; Kasuga, Takekuni; Doi, Osamu; Tanaka, Hitoshi. Gan No Rinsho, 13: 1114-18 (Dec. 1967). (In Japanese).

A phantom was constructed to simulate the human body for making dose distribution measurements. The data obtained were used to establish the relation between the site of rib fracture and the lung damage which occurs as a side effect of irradiation and the dose distribution. The 2,000 Ci Toshiba rotating ^{60}Co source was used with the MacWhirter method for the irradiation measuring the dose by means of a Toshiba depth dosimeter and glass dosimeters, calibrated with a Phillips dosimeter. The dose readings were used to construct isodose lines in the lateral and vertical cross sections, making it possible to position the body for radiation and to define the field for optimum irradiation effect within the region receiving the highest dose that would correspond to the site of maximum frequency of rib fracture. The advantages and weaknesses of this technique are discussed. (TTT)

31769 DEPOSITION OF INHALED PARTICLES IN LUNGS. Vaughan, W. J.; Vaughan, B. E. (Naval Radiological Defense Lab., San Francisco). Nature (London), 221: 661-2(Feb. 15, 1969).

Differences in experimental results relating particle size and deposition in the human lung are discussed, with special reference to interpretation of the results. Confusion in terminology may account for many of the discrepancies, as also may be method of breathing in the tests. Reference is also made to studies by the authors on the deposition of labeled monodisperse glycerol particles in the lungs of rats. (UK)

31770 ^{137}Cs BODY BURDENS AND BIOLOGICAL HALF-LIFE IN CHILDREN AT TAMPA, FLORIDA, AND LAKE BLUFF, ILLINOIS. Karches, G. J. (National Center for Radiological Health, Cincinnati); Wheeler, J. K.; Helgeson, G. L.; Kahn, B. Health Phys., 16: 301-13(Mar. 1969).

Body burdens of ^{137}Cs were studied in September and October 1966 at two of twenty-one children's homes in which the National Center for Radiological Health determines monthly dietary intakes of cesium-137. Cesium-137 intakes in Tampa, Florida, were highest among the twenty-one institutions; in Lake Bluff, Illinois, the intakes were near the average for all institutions. The subjects were thirty children in one home and thirty-five in the other at ages between 6 and 16 years. Height, weight, sex, age, and gross body morphology were recorded for each subject. Cesium-137 and ^{40}K contents were measured in a truck-mounted shadow shield by means of a 4 in. × 8 in. NaI(Tl) detector and a 512-channel pulse height analyzer. The instrument was calibrated with phantoms consisting of 2-lb. boxes of granulated sugar, each with inserted radioactivity standards of ^{137}Cs or ^{40}K. The minimum detectable activity of the instrument system for ^{137}Cs in children was 1 nCi, and the standard deviation was approximately 0.4 nCi for 30-min counting times. Cesium-137 and potassium body contents and concentrations were log-normally distributed among the children within each institution. Geometric mean values of ^{137}Cs body burden were 7.7 nCi at the institution where ^{137}Cs intakes were highest, and 3.4 nCi where ^{137}Cs intakes were near the average. Cesium-137 body burdens were related to known intake levels to estimate a mean biological half-life of 46 days. (auth) (UK)

31771 RELATIONSHIP BETWEEN BODY BURDEN AND URINARY EXCRETION OF ^{137}Cs IN MAN FOLLOWING FALLOUT ^{137}Cs INGESTION. Uchiyama, M.; Iinuma, T.; Saiki, M. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 16: 277-86(Mar. 1969).

Monthly observations were made simultaneously on the body burden and the daily urinary excretion of ^{137}Cs and K for a male adult group of five to eighteen subjects during the period November 1963 to March 1967. The average monthly ratio of body burden to daily urinary excretion (Q/Eu) and the S.D. of the ratio were 124 ± 27 after April 1965 when 72 hr-urine samples were collected. ^{137}Cs in the body in mμCi could be estimated as 120 times that in daily urinary excretion or alternatively as 1.4 cesium units (pCi of ^{137}Cs/g K) in the daily urinary excretion. Both estimates showed about 20% S.D. Application of a two component exponential model was tried to analyze the experimental values of Q/Eu and found to be useful to estimate body burdens resulting from chronic intake of this radionuclide. The average biological half-life (T_L) for this group was 85 days. (auth)(UK)

31772 ^{210}Po AND ^{210}Pb IN THE ARCTIC FOOD CHAIN AND THE NATURAL RADIATION EXPOSURE OF LAPPS. Kauranen, Pentti; Miettinen, Jorma K. (Univ. of Helsinki). Health Phys., 16: 287-95(Mar. 1969).

Measurements of ^{210}Po and ^{210}Pb concentrations in samples from Lapland and reference samples from southern Finland showed that the arctic food chain, lichen–reindeer–man, maintains a high ^{210}Po concentration in soft tissues of reindeer-breeding Lapps (about 12 times higher than in southern Finns). For ^{210}Pb the corresponding "excess" factor appears to be much lower (about 2.5). The results are discussed in the light of the parameters of the ICRP-tables. The dose rate delivered by the α-activity of ^{210}Po to the Lapps is estimated. (auth)

31773 RELATION OF LUNG DOSE RATE TO WORKING LEVEL. Morken, D. A. (Univ. of Rochester, N. Y.). Health Phys., 16: 796-8(June 1969).

The term working level (WL), used with reference to uranium mines, represents the concentration of radioactivity in a given air environment. It is defined as any combination of short-lived radon daughters (Ra, A, B, C, and C′) in one litre of air that results in the emission of 1.3×10^5 MeV of potential α energy from radioactive decay of these radon daughters to Ra D, and represents a dose rate to which radiological dose rate to lung is assumed proportional. Use of the term is discussed, and it is concluded that it is not suitable as a dose rate estimator, and is not appropriate for use in studies of risks involved by exposure to radon daughter products. (UK)

31774 RADIOLOGICAL CALIBRATION AND STANDARDIZATION FOR HEALTH PHYSICS: A PROGRAM, A PLEA, AND A PROPOSAL. Kathren, R. L.; Larson, H. V. (Battelle-Northwest, Richland, Wash.). Health Phys., 16: 778-82(June 1969).

The general philosophy of the subject is discussed, and the program at Pacific Northwest Laboratory for radiological calibration and standardization is described. It is stated that, in general, despite the efforts of the ICRU, NBS, and other interested groups, the entire position in this field is chaotic, and an important reason for this is lack of good definitive nomenclature; measurement techniques and instrumentation are another area of confusion. A plea is made for recognition of the need for uniform terminology, and standard techniques and instrumentation. Inaccuracies in measurements should be cited, and error ranges placed on reported values. Proposals are made for improvement of the position, and primary, secondary, laboratory, and operational standards are discussed. (UK)

31775 RBE OF THE M.I.T. MEDICAL THERAPY NEUTRON BEAM IN MONOLAYER CULTURES OF HELA CELLS. Davis, M. A. (Harvard School of Public Health, Boston); Little, John B.; Reddy, A. R.; Ayyangar, K. Health Phys., 16: 469-73(Apr. 1969).

Due to the possibility of initiating another clinical trial of boron-neutron capture therapy of malignant brain tumors, it is important to obtain more information on the physical characteristics and biological effectiveness of the neutron beam to be used for the therapeutic irradiations. The first of a series of experiments designed to determine both the physical properties and biological effects of this beam is described. The latter were studied in HeLa cells with no boron present; a situation stimulating that of normal brain tissue which may be exposed during a therapeutic irradiation of neoplastic tissue containing ^{10}B. The reactor beam was composed of three major factions: γ rays, fast neutrons, and thermal neutrons. Dosimetry using LiF thermoluminescence and a tissue equivalent ionization chamber, a silicon diode semiconductor, and gold foil activation, respectively, showed that 50% of the dose arose from the γ component and 50% from the neutron component. The RBE for this beam compared to 250-kVp x rays (RBE = 1.0) was 1.51, the value being obtained by comparing the D_0 values of each dose-survival curve. Since the RBE of the γ component compared to 250 kVp x rays is 0.8 and the reactor beam RBE was 1.51, the RBE of the neutron component was approximately 2.2 for reproductive failure in HeLa cells. (auth) (UK)

31776 ALPHA RADIOACTIVITY IN COAL MINE DRAINAGE IN WESTERN PENNSYLVANIA. Caldwell, Roger D.; Crosby, Ronald F.; Lockard, M. Paul (Nuclear Materials and Equipment Corp., Apollo, Pa.). Radiol. Health Data Rep., 9: 725-9 (Dec. 1968).

The average gross α radioactivity in the Kiskiminetas River during 1966 to 1967 was determined from three individual sites above, between, and below the plutonium and uranium plants near Leechburg and Apollo respectively. The results showed extremely high α radioactivity in the water, due primarily to uranium-234 and -238. Coal mine drainage with its attendant uranium content appears to be responsible for the high levels of α radioactivity. Data are presented in tabular form. (E.R.B.)

31777 RADIOLOGICAL HEALTH DATA. Radiol. Health Data Rep., 9: 730-71(Dec. 1968).

The data presented in this section of Radiological Health Data and Reports are divided into five sections. In the section on milk and food surveillance, data are presented on the calcium and potassium content of milk in the Panama Canal Zone, Puerto Rico, and the United States during May 1963 to March 1966. The accuracy of the sampling and analytical testing procedures of the different milk network stations was determined using ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba. Standardization of reporting techniques was achieved and data for September 1967 through August 1968 are presented for the same radioisotopes. In the section on water surveillance, the gross α and β radioactivity of surface waters in the United States during June 1968 and the radium-226 and uranium content of surface waters in the Colorado River Basin during 1967 are reported. In the section on air and deposition data, the gross beta radfbactivity in surface air and precipitation during August 1968 are reported for the United States, Canada, and Pan America, and the plutonium-238 and -239 content of airborne particulates and precipitation during July to December 1967 are reported for selected areas of the United States. Data are also presented on the ^{137}Cs, ^{89}Sr, and ^{90}Sr content of muscle in caribou and reindeer in Alaska during March to May 1968, the gross radioactivity levels of surface air, surface and supply water, and soil and vegetation at Atomics International Plants during 1967 to 1968, and the uranium content and beta radioactivity in air and water samples at the Union Carbide Corporation's Paducah Plant during January to June 1968. Five underground nuclear tests are reported by the Atomic Energy Commission during November 1968 at the Nevada Test Site, and one nuclear test at the northern Soviet testing area. (E.R.B.)

31778 RADIATION DOSES TO CHILDREN'S THYROIDS FROM ^{131}I IN MILK. Neill, Robert H.; Robinson, Paul B.

(Bureau of Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 10: 1-9(Jan. 1969).

Measurements of ^{131}I in milk taken since 1957 were used to estimate the average cumulative radiation doses to children born and living in selected U. S. cities. The cumulative doses were summed for a cohort (born in a particular year and city) from quarterly doses calculated by varying thyroid weight, uptake factor, and milk consumption, as a function of the age of the child and concentrations of ^{131}I in milk as a function of time and location. Average values of these variables were selected for each quarter. For a given concentration of ^{131}I in milk, the population receiving the greatest dose were milk-drinking infants of 6 to 11 months of age. Considerable variation was found to exist in cumulative doses for children raised in different cities. Within a particular city, there was a large variation in thyroidal doses for children born in different years. The largest doses were 1,750 mrem and 1,625 mrem, received by children born in 1957 in St. Louis and Salt Lake City. At the time of the cessation of weapons testing in 1963, the average child of 6 yrs of age in four of the five U. S. cities where data were available had received man-made cumulative thyroidal doses greater than his cumulative natural dose. Because of the relative absence of ^{131}I in the environment for the past 4 yrs, the children of today whose cumulative fallout exposure exceeded their natural background exposure were those born in 1957 in Cincinnati, Salt Lake City, and St. Louis. From the results obtained from these three out of five cities for which data were available, it was apparent that children born in 1957 in Cincinnati, Salt Lake City, and St. Louis, and possibly in some other unmonitored areas of the United States, had cumulative thyroidal doses from ^{131}I following atmospheric weapons tests greater than their cumulative natural background doses, but less than the cumulative dose at an annual dose rate equal to the Radiation Protection Guide (RPG) during the same period. (auth)

31779 RADIOLOGICAL HEALTH DATA. Radiol. Health Data Rep., 10: 11-45(Jan. 1969).

Data are presented in tabular form on the results of surveillance activities in North, Central, and South America of radiological interest to man. Included in the results presented for milk and food surveillance activities is the ^{137}Cs, ^{140}Ba, ^{131}I, ^{89}Sr, and ^{90}Sr content of milk in samples from Canada, United States, and Central and South America during October 1967 through September 1968, and the ^{137}Cs, ^{226}Ra, ^{90}Sr, calcium, and potassium content of children's diets in the United States during April to June 1968. Results presented from water surveillance activities in the United States include the α and β radioactivity of surface water samples from selected stations during July 1968. Air and deposition surveillance results include the gross β radioactivity in surface air and precipitation samples collected in United States, Canada, and South America during September 1968, the plutonium-238 and -239 content of samples of airborne particulates collected throughout the United States during January to March 1968, and the plutonium-239 content of atmospheric precipitation samples collected at the same stations covering the same times. Data from environmental sampling at AEC installations include α and β-γ radioactivity levels in environs of the Portsmouth Area Gaseous Diffusion Plant during January to June 1968, and the α and β radioactivity of atmospheric samples, the α radioactivity and radioisotope content of deposition samples, the radionuclide content of Savannah River water samples, the tritium, ^{90}Sr, and ^{131}I content of milk samples from local dairies, and environmental γ radiation levels at the Savannah River Plant during January to June 1968. The USAEC announced three underground nuclear tests at the Nevada Test Site, and the detection of one Soviet and one Chinese nuclear test during December 1968. (E.R.B.)

31780 ALPHA RADIATION EXPOSURE LEVELS IN UNDERGROUND URANIUM AND OTHER MINES. Radiol. Health Data Rep., 9: 719-23(Dec. 1968).

Surveys of radon daughter concentrations in air in underground mines (noncoal) were conducted by the Bureau of Mines. Radon daughter sampling was performed using the conventional filtered-air method, and concentrations were expressed as working levels (any combination of radon daughters in 1 l of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy. From 1959 to 1962, only working areas were sampled, while from 1969 on, full-shift exposure rates were estimated. Recent survey data are included (April 1, 1967 to June 30, 1968) on radiation exposure rates in underground uranium mines sampled at quarterly intervals. As a result of the surveys, suggestions were made for reduction of the working levels by changing the ventilation systems in the mines. Nonuranium mines were sampled at the same times and intervals as the uranium mines and it was concluded that the mines were generally adequate to meet a 1.0 working level standard. Data on all mine surveys, alpha levels, and recommendations are presented in tabular form. (E.R.B.)

31781 ^{137}Cs CONCENTRATIONS IN ALASKANS DURING THE SPRING OF 1967. Rechen, Henry J. L. (National Center for Radiological Health, Rockville, Md.); Mikkelsen, Richard L.; Briscoe, O. Glen; Steiner, John F. Jr. Radiol. Health Data Rep., 9: 705-17(Dec. 1968).

During April and May 1967, ^{137}Cs concentrations were measured by the National Center for Radiological Health, Public Health Service, in 1,334 residents of 13 Alaskan villages and cities where caribou and reindeer are major sources of meat. Unshielded 7.5 × 7.5 cm NaI(Tl) scintillation detectors, held in the lap, were used for subjects of both sexes, from 4- to 91-yr old, weighing 16 to 100 kgms. The maximum ^{137}Cs concentrations ranged from 16.58 to 20.76 nCi/kg for males and from 12.92 to 18.21 nCi/kg for females. Cesium-137 concentrations were highest in Ambler, Selawik, Noorvik, Shungnak, and Anaktuvuk Pass, intermediate in Shishmaref, Noatak, Mekoryuk, Egegik, and Teller, and lowest in three coastal cities where whaling is done (Wainwright, Point Hope, and Barrow). The Bureau of Indian Affairs (BIA) school lunch program, where used, did not appear to reduce significantly the ^{137}Cs concentrations in children. Average concentrations in men who were measured both years at Anaktuvuk Pass dropped 37.5 percent from 1966 to 1967; Selawik males showed a 15.7 percent decrease, while ^{137}Cs concentrations in adult male residents of Egegik increased 2 percent. The radiation dose index defined in this report, for the highest individual value measured in 1967 was 0.17 rad/annum. The individual was an 82 kg man whose ^{137}Cs concentration was 21 nCi/kg. The guidance published by the Federal Radiation Council suggests that, while surveillance should be continued, no protective action appears to be necessary at this time. (auth)

31782 DOSIMETRIC PRECISION REQUIRED IN RADIOTHERAPY CONSEQUENCES OF THE CHOICE AND REQUIRED PERFORMANCE OF THE DETECTORS. Wambersie, A. (Univ., Louvain, Belg.); Dutreix, J.; Dutreix, A. J. Belg Radiol., 52: 94-104(1969). (In French).

Radiobiological as well as radiotherapeutic experience tends to demonstrate that high accuracy is required in the assessment of the dose. In order to illustrate this statement three examples are presented. They are taken from cell population theory, mammalian radiobiology, and clinical observation. The specifications required for the dosimeters differ according to the type of measurement to be performed: absolute measurements of the absorbed dose on a definite point, relative measurements in phantoms or in vivo. The advantages for relative measurements of the ionization chamber, film, $FeSO_4$, and thermoluminescent dosimeters are compared according to their volume, handiness, sensitivity, and energy dependence. Finally, the problems of absolute measurements and calibration of the dosimeters are discussed. Calibration can be performed by direct comparison or by means of a transport dosimeter. $FeSO_4$ has certain advantages as a reference dosimeter for high energy photons and electrons. (auth)

31783 RESULTS OF TREATMENT AND THE EXPERIENCE IN THE USE OF NUMERICAL COMPUTERS IN PLANNING RADIATION THERAPY BY THE METHOD OF LINEAR PROGRAMMING. Sinitsyn, R. V.; Strashinin, A. I.; Palladieva, N. M.; Gerasimyak, V. G.; Dianina, E. S.; Dyatlova, N. N. (Leningrad Scientific-Research Inst. of Roentgen-Radiology). Med. Radiol., 14: No. 3, 59-63(Mar. 1969). (In Russian).

For the dosimetric substantiation of the plan of ^{60}Co γ and x radiation therapy and choice of optimal conditions of tele-irradiation the technique of linear programming with the solution of the task on electron numerical computer was used. According to the obtained dosimetric program, 76 patients with cancer of the esophagus and lung were treated, and the clinical results of treatment are presented. Linear programming enables individualized dosimetric plans of therapy, control of the dose field, and reduction of the severity of radiation complications in healthy tissues and organs surrounding the tumor. (auth)

31784 OBTAINING OF VOLUMETRIC DOSE FIELDS IN ^{60}Co GAMMA THERAPY WITH THE AID OF ELECTRONIC COMPUTERS. Krongauz, A. N.; Klepper, L. Ya.; Fadeeva, M. A.; Futerman, N. E. (Moscow Scientific-Research Inst. Central Inst. of Economics and Mathematics, Moscow). Med. Radiol., 14: No. 3, 26-31(Mar. 1969). (In Russian).

A method is described for obtaining information on the dose distribution by separate calculation of dose distributions for five transverse sections in four-field irradiation (^{60}Co γ source) of esophageal tumor. The dose distributions were calculated on a numerical computer according to a modified program. On the basis of data derived the integral absorbed doses were calculated by the routine technique and by all five distributions. The results are tabulated. (auth)

31785 PROGRAMMING FOR DOSIMETRY OF DEVICES FOR X RADIATION THERAPY. Marova, Yu. M.; Trius, E. B.; Krushchov, M. M.; Raifel, V. A. (Central Inst. for Medical Graduate Women, Moscow, Moscow City Clinic). Med. Radiol., 14: No. 3, 11-15(Mar. 1969). (In Russian).

Isodose curves are presented for use in calculating dose distribution for x radiation. Applications in planning the dose for radiation treatment are discussed. (C.H.)

31786 CALCULATION OF TOTAL DOSE DISTRIBUTIONS ON A NUMERICAL COMPUTER. Kvasov, V. A.; Astrakhan, B. V. Med. Radiol., 14: No. 3, 15-21(Mar. 1969). (In Russian).

For the calculation of dose distributions of alternative plans of radiation therapy on a computer, use is made of experimental isodose pictures of single fields. For the given γ irradiation technique, only one dose grid is introduced into the computer memory. Evaluation of variations of the distance source—surface and curvature of the transverse section of the patient's body—is done by the computer on the basis of simple analytical expressions. (auth)

31787 DIRECTIONS OF RESEARCH OF SPECIALIZED COMPUTERS FOR THE CALCULATION OF DOSE DISTRIBUTIONS. Golovan, V. A.; Krongauz, A. N.; Ushakov, V. B. (Moscow Scientific-Research Inst. of Electronic Computers, Moscow Scientific-Research Inst. of Roentgen-Radiology). Med. Radiol., 14: No. 3, 32-7(Mar. 1969). (In Russian).

Design criteria of specialized computers for clinical dosimetry and measurements of absorbed dose of γ and x radiation for therapy are discussed. The requirements to such machines are listed. An important requirement is the presence of automatic data infeed and outfeed, and the possibility of using the machine in joint work with the operator. (auth)

31788 METHODS FOR CALCULATING DOSE FIELDS. Lur'e, A. I. (Moscow Inst. of Applied Geophysics). Med. Radiol., 14: No. 3, 44-6(Mar. 1969). (In Russian).

A method is described for the compilation of the γ or x radiation dose field for therapy using computers. The main dose field equations and the technique of determination of dose distributions are described. Protection, apparatus, and radiation sources for a wide range of therapeutic and other uses are discussed. (auth)

31789 COMPUTER CALCULATIONS OF THE DOSE DISTRIBUTION FOR NYLON THREADS WITH ^{60}Co GRANULES. Karp, L. A.; Klepper, L. Ya.; Pavlova, T. G.; Futerman, N. E. (Central Inst. of Economics and Mathematics, Moscow, Moscow Inst. of Roentgen-Radiology). Med. Radiol., 14: No. 3, 7-11(Mar. 1969). (In Russian).

Calculations of the volumetric distribution of absorbed doses from small sources of ^{60}Co beads used in intratissular irradiation were performed using computers. The accuracy of the calculation at the point was ±15%. Evaluation was done in comparison with experimental data. (auth)

31790 USE OF METHODS OF STATISTICAL TESTS AND LINEAR PROGRAMMING FOR THE CALCULATION OF OPTIMAL DOSE FIELDS IN HETEROGENEOUS MEDIA. Parfenov, E. N.; Ignat'ev, U. V. (Inst. of Medical Radiology, Moscow). Med. Radiol., 14: No. 3, 50-8(Mar. 1969). (In Russian).

A statistical technique for calculation of the dose distribution of γ quantums in a biological object is presented that enables more accurate determination of the dose in elementary objects with consideration of the medium heterogeneity. It also gives a physical picture of the interaction of γ quanta with elements in biological tissue. (auth)

31791 AUTOMATIC SETTING OF THE TASK OF LINEAR PROGRAMMING FOR THE CHOICE OF THE OPTIMAL METHOD OF IRRADIATION. Sinitsyn, R. V.; Shilko, V. N. (Lab. of Medical Sources of Ionizing Radiation and Clinical Dosimetry, Moscow). Med. Radiol., 14: No. 3, 38-43(Mar. 1969). (In Russian).

The use of linear programming for the selection of optimal irradiation regimens for therapy using γ and x radiation are discussed. Programs are described. (auth)

31792 PREDICTION OF EXTERNAL GAMMA DOSE FROM NUCLEAR EXCAVATION OF A SEA-LEVEL CANAL. Ferber, Gilbert J.; List, Robert J. (Air Resources Labs., Silver Spring, Md.). Contract SF 54-351. Bioscience, 47: 234-7(Mar. 1969).

The potential radiological hazard to man and his environment from quantitative estimates of the external γ dose was assessed for the proposed nuclear excavation of a sea-level canal in either Panama or Colombia. This would require the use of several hundred nuclear devices. Quantitative fallout is based on prediction of a model of the radioactive cloud and proceeds to the calculation of atmospheric transport and deposition of the nuclear debris. The nuclear yields and burial depths of the explosives, selected to produce the desired canal dimensions, would determine the amount of radioactivity produced and the fraction of the total activity vented into the atmosphere. A sample detonation schedule was developed from the days on which favorable winds were observed and fallout calculations were made using the actual winds on the selected dates. Analysis of the weather data obtained from Route 17 in Panama indicates that favorable winds occur with sufficient frequency to permit the nuclear excavations to be conducted under such restraints. However, a detailed analysis of the combined effects of fallout, rain scavenging, and air blast must be completed before final conclusions can be drawn. This analysis is in progress along with similar studies for Route 25 in Colombia. (BBB)

31793 DETERMINATION OF TUMOUR DOSE BY TRANSMISSION MEASUREMENTS IN ROENTGEN ROTATION TREATMENT OF THE OESOPHAGUS. Nordberg, Ulla-Brita (Univ. of Lund, Sweden). Acta Radiol., Ther., Phys., Biol., 7: 401-16 (Dec. 1968).

A device for simultaneous measurement of the transmission through a patient at different levels is described. Correlation between target dose and transmission is obtained by measurements in phantoms as well as in patients. The discrepancy in relation to conventional tissue-equivalent calculations are discussed. (auth)

Radiation Protection

Refer also to abstracts 31300, 31809, and 32863.

31794 (CONF-690317-4) PREPAREDNESS FOR RADIATION ACCIDENTS: THE ROLE OF THE OPERATOR AND THE INFLUENCE OF MODERN DESIGN. Bell, Mayhue A. (Division of Operational Safety (AEC), Washington, D. C.). [1969]. 11p. (SM-117/56). Dep. CFSTI.

From Seminar on Agricultural and Public Health Aspects of Environmental Contamination by Radioactive Materials, Vienna, Austria.

The operator's primary effort goes into preventing accidents. Good design, construction, a safety conscious and well qualified operating staff, well planned operating procedures are the measures used to lessen the chances of an emergency. However, it is impossible to ensure that these measures will always work or that an accidental release of hazardous materials will not occur. Emergency plans must be prepared and periodically reviewed to handle abnormal operating conditions that could lead to an accident if not corrected promptly and emergency conditions in the plant and offsite that could result from a radiation accident. Protection of operating personnel and the operator's property must be provided through emergency procedures. For offsite conditions, close coordination with public authorities is required. Clear responsibility and authority must be specified by the operator and public authority to ensure that appropriate emergency action is taken. Appropriate instrumentation and other means for keeping continually informed of emergency conditions must be available during and following the accident. The general requirements for future planning for offsite radiological emergencies will be the same as today's requirements, however, the plans must take into account the different hazards, such as plutonium releases. The operator's emergency procedures for handling abnormal conditions that could lead to accidents and emergency plans for dealing with accidents will change and will depend upon plant design and the specific hazards involved. As technology improves for thermal reactors, the probability of accidents will decrease. However, the fast reactor and other new concepts will create new problems. Whatever new technology is introduced, the ultimate goal will be to decrease the probability that the public will be exposed to releases of radioactivity. Reducing the consequences of a serious accident must be kept in mind by both the operator and public authorities. Emergency planning for all nuclear activities should be brought to a uniformly high standard. Coordination of the plan should be directed toward maximum use of technical resources of the operator, public authority and the nation. The offsite emergency measures for protection of the public will be effective in greater or lesser degree depending on how well the operator and the public authorities are informed about the plan. (auth)

31795 (RPS-AR-1) ANNUAL REPORT [ON RADIATION PROTECTION], FOR THE YEAR 1967. (Ministry of Public Health, Bangkok (Thailand). Radiation Protection Service). 23p. Dep.

Various aspects associated with radiation protection services provided by the Ministry of Public Health in Thailand are discussed. Topics include registration of x-ray machines, radiation survey and calibration services; and advisory services. A project

dealing with area surveys of stray radiation with the use of radiation monitoring films is described. (B.G.D.)

31796 (SZS-17/68) PRIMARY LITERATURE IN THE FIELD OF RADIATION PROTECTION. Scheel, H. (Staaliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Oct. 1968. 33p. (In German). Dep.

Citation data obtained from two volumes of Health Physics and Giornale Di Fisica Sanitaria E Protezione Contro Le Radiazioni were used to survey the primary literature in the field of radiation protection. The results showed that nearly 60 per cent of all citations were derived from journals; about 20 per cent of all cited journals contained 75 per cent of journal citations; journals of medicine and biology were most frequently cited; most of the cited journals were published in the U. S. A.; about 50 per cent of all citations were not older than 5 and about 80 per cent not older than 10 years; and there are two components of literature, the classic and the ephemeral. (auth)

31797 PRECISION TECHNIC TO MINIMIZE RADIATION. Medwedeff, Fred M.; Elcan, Paul D. (Vanderbilt Univ., Nashville). Dent. Surv., 43: 45-53(Oct. 1967).

A stainless steel cone liner is used to reduce cone scatter radiation and filter scatter radiation during dental radiography. The liner also improves the quality of the film image by eliminating fog. The suggested technique utilizes a film holder attached to a collimating, aiming element. This device has a circular stainless steel shield or collimator with a rectangular window and handles for the convenience of the patient and operator. The window allows a small rectangular beam to pass and is properly aligned with the film in the holding element. Moreover, the instrument holds the film in the mouth in the proper relation to the teeth for the paralleling technique. A metal supporting shield which is part of the film holder acts as a barrier against exit radiation, thereby providing periapical shielding for the opposite side of the arch. (TSS) (BBB)

31798 A PROTECTIVE COVER FOR THE TESTICLE, AN EASY-TO-USE RADIATION-PROTECTION DEVICE FOR MEDICAL PRACTICE. Ekert, Friedrich (Wittelsbacherstrasse, Munich). Muenchen. Med. Wochenschr., 109: 527-8(Mar. 10, 1967). (In German).

The use of a radiation shield for protection of the testes and ovaries was discussed. More than 98% of the incident radiation was shielded out during roentgenography of the abdomen, upper femur, and hip and in pyelograms. The construction of the shield was described and illustrated. In addition to the radiation protection afforded by the shield, it was simple to use and could be modified to permit x-ray exposures of patients in the standing position. (BBB)

Safety Procedures

Refer also to abstracts 31718, 31731, 31773, and 31989.

31799 (FMB-68-8) PROTECTION AGAINST RADIOACTIVITY IN DITCHES. Ritschard, Urs (Forschungsinstitut fuer Militaerische Bautechnik, Zurich (Switzerland)). Dec. 1968. 63p. (In German). Dep.

The assumption is made that tactical nuclear weapons are used and that military personnel are taking cover at the bottom of a trench. Neutron as well as gamma doses are calculated for length, width, and depth of the trench and for various distances and elevations of the nuclear explosion. (H.B.G.)

31800 (JUL-543-ST) REPORT OF 1967 WORK OF THE CENRAL DEPARTMENT OF RADIATION PROTECTION. Keller, M.; Tzschaschel, R. (eds.) (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Aug. 1968. 212p. (In German). Dep.

This is the first published annual report of the health physics department of the reactor center in Juelich. The 1967 publication consists of three parts: routine surveillance of environment, laboratories, and personnel; research and development for improvement of radiation protection; review of publications and lectures given by staff members. Centralization of radiation protection problems in one department proved to be very effective; medical problems are handled by a different organization within the center. (H.B.G.)

31801 (PNE-G-33) OPERATIONAL SAFETY PLAN. Project GASBUGGY. (Nevada Operations Office (AEC), Las Vegas). Oct. 1967. 36p. Dep. CFSTI.

The recommendations and plans, concerning the safety of project participants and the public and the prevention of damage to private, industrial, and other facilities, as developed by consultants, contractor organizations, and government agencies for Project Gasbuggy are presented. The operational safety plan includes: preshot evacuation of nearby residents and livestock; pre- and post-shot structural survey for documentation of claims; investigation of any claims for damage; survey of surface and subsurface installations of oil and gas wells, mines, and tunnels; provision of weather data and forecasts for predictions of radioactive effluent dispersion; on-site radiological safety and industrial hygiene including individual MPD calculations; off-site radiological safety to provide the same monitoring services to a distance of 50 miles or as far as necessary; post-shot evaluation of extent of ground water contamination; and measurement of seismic disturbances for purposes of public safety and to provide a basis for predictions for other yields and situations. (E.R.B.)

31802 PROBLEMS INVOLVED IN SETTING BASIC GUIDANCE FOR RADIOLOGICAL PROTECTION. Tompkins, Paul C. (Federal Radiation Council, Washington, D. C.). Amer. J. Public Health, 59: 305-10(Feb. 1969).

Some problems encountered by the Federal Radiation Council (FRC) in setting basic guides for radiation protection are cited, with emphasis on considerations taken up by the FRC Working Group in developing recommendations for radiation protection in uranium mines. As a general aid for developing a systematic approach to the problems considered, eight questions were identified upon which agreement must be reached to establish a consensus. To establish a basis for answering these questions, the U mining study was divided into three parts that were examined separately. One task force considered the general problems associated with the operation of the industry. The second study, conducted by the Public Health Service, reviewed all the human data relating to the hazards of U mining. The third subject was a critical review of basic biological models and their relation to radiation dosimetry. Observations on United States U miners who started underground mining before 1955 clearly demonstrated an association between exposure to Rn daughters and a higher than expected incidence of lung cancer at high cumulative exposures. The degree of risk at low levels of cumulative exposure could not be determined from available epidemiological data. Differences of competent scientific opinion arose in regard to the risk associated with different exposure conditions. The final selection was necessarily a matter of judgment, and it involved an evaluation of several factors beside scientific opinion on what the dose-effect relation might be. Two factors, also considered, that were just as important in setting basic radiation protection guidance as the evaluation of the risk to be associated with exposure were: the feasibility of applying available techniques in the form of practices and procedures to limit potential exposure, and alternate nonradiation hazards that the control program itself might introduce. Exposure models were discussed and illustrated with reference to Rn and its daughters. (BBB)

31803 RISK OF MICROWAVE RADIATION WITH REGARD TO PREVENTIVE EXAMINATIONS OF PERSONNEL. Pihak, Milan; Servus, Vladimir; Schubertova, Jarmila. Voj. Zdravot. Listy, 38: 7-9(1968). (In Czech).

A summary of opinions is given as to the effects of microwave radiation on humans. Results of pre-employment examinations of technicians and other personnel and thorough examinations during hospitalization are presented. No marked deviations from the normal were found. Pre-employment examination of all microwave personnel is proposed. (auth)

31804 MEDICAL APPLICATIONS OF RADIATION AND THEIR SAFETY ASPECTS. Murthy, T. G. Krishna (St. John's Medical Coll., Bangalore, India). J. Indian Med. Ass., 48: 268-72(Mar. 16, 1967).

Medical applications of ionizing radiation, associated hazards, and safety precautions are reviewed. With diagnostic and therapeutic x rays, precautions must be taken against the primary beam and scattered radiation. The primary beam should never be directed towards doors or windows. Sufficient protection in the form of lead filters must be provided. The radiologist and technician must wear lead aprons and lead gloves. A lead protective barrier which is mounted on castors can be used to protect the technician at the control panel. Personnel monitors in the form of film badges must be worn by all radiation workers. Monitors should be used to ensure that the maximum permissible levels of radiation are not exceeded. Exposure to external radiation can be reduced by completing the work as quickly as possible, maintaining distance, which is very effective in reducing exposure, as intensity varies inversely as square of distance, and good shielding between source and person. How shielding depends on the strength and type of radiation is discussed. Numerous tables are provided including those which show the properties of x rays of various intensities, properties of individual radioisotopes, somatic cell radiosensitivity, radioisotope instrumentation, and toxicity and tissue localization of radioisotopes. (BBB)

Civil Defense

31805 (FMB-67-4-B) TWELVE RULES OF THUMB FOR THE CORRECT BEHAVIOR IN SHELTERS FOR RADIOACTIVELY CONTAMINATED SURROUNDINGS. Pretre, S. (Forschungsinstitut fuer Militaerische Bautechnik, Zurich (Switzerland)). Sept. 1967. 36p. (In French). Dep.

Based on dosimetry inside and outside of a fallout shelter after an atomic explosion, several basic rules are described. Duration of occupancy of the shelter, length of temporary outside activities, and return to above ground living are discussed. (H.B.G.)

31806 AFTER A NUCLEAR ATTACK. Povaiyaev, A.; Chernosvitov, Yu. Zemledelie, No. 6, 71-3(1968). (In Russian).

Farming of radioactive soil is discussed. As with surface contamination of plants, the most serious element associated with radioactive contamination of the soil is ^{90}Sr. Decontamination measures may be governed by the number of strontium units. Current sanitary regulations permit 270 strontium units in human foodstuffs. Accumulation of ^{90}Sr in the plant is governed by two factors: ^{90}Sr content in the soil; and the type of soil and its content of assimilable calcium. Sample calculations of the number of strontium units to be expected from various crops are given. The agronomist should first make a map of the distribution of ^{90}Sr and assimilable calcium in the soil and then calculate the levels of possible contamination of the yield on the various fields of the farm. Crops should be planted in accordance with the different levels of contamination; industrial crops should be planted where radioactivity is high, fodder crops where contamination is low, and food crops where contamination is lowest. The passage of ^{90}Sr from the soil to the plant should be reduced in areas where food crops are grown by the following measures: direct removal of ^{90}Sr from the surface layer of the soil; use of agents reducing this passage of ^{90}Sr into the plant; and selection of crops with the least capacity to assimilate ^{90}Sr from the soil. (JPRS) (TSS)

31807 CIVIL DEFENSE AND EMERGENCY SERVICES. REPORT ON STUDIES MADE DURING OVERSEAS VISIT, MAY-AUGUST, 1968. Perth, Western Australia, Premier's Department, 1969. 47p.

Description is given of civil defense organizations and their emergency services in India, Israel, Italy, The Netherlands, West Germany, United Kingdom, Ireland, U.S.A., and Malaysia. (Australia)

Legal Aspects

Refer also to abstracts 31795, 31802, and 32010.

31808 (SZS-2/69) RESPONSIBILITY FOR RADIATION PRO TECTION AND THE LIABILITY FOR RADIATION INJURIES. Iffiaender, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Jan. 1969. 23p. (In German). Dep.

On the basis of legal regulations currently in force the tasks of the National Center for Radiation Protection of the G.D.R. are outlined taking into consideration the main objective of radiation protection: the protection of individuals against radiation exposure. For institutions in which radioactive materials are handled or nuclear or other installations emitting ionizing radiation are operated the responsibility of the authority in charge for radiation protection is explained. The fundamental principles of the regulation of liability for radiation injuries are outlined for the operation of x-ray and nuclear installations as well as the handling of radioactive materials. (tr-auth)

31809 (SZS-4/69) RECOMMENDATIONS FOR DECONTAMINATION OF SURFACES IN ROOMS, EQUIPMENT, AS A MEANS OF INDIVIDUAL PROTECTION, AS WELL AS THE SKIN. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Feb. 1969. 29p. (In German). Dep.

The present recommendations apply to: the decontamination of rooms in which radioactive materials are used; equipment, work clothing, shielding, and other means of individual protection which are used in connection with corresponding operations; as well as to the decontamination of the skin of persons who work with radioactive material. The recommendations have been prepared in conformity with the "Regulations for Handling Radioactive Materials" and "Standards of Radiation Protection", which have been approved in the framework of RGW. The present recommendations do not apply to the decontamination of technological equipment used in nuclear engineering. (tr-auth)

31810 TECHNO-LEGAL FACTORS IN DEVELOPING THE RADIATION DOSE RECORD. Hart, J. C. (Oak Ridge National Lab., Tenn.). J. Occup. Med., 11: 77-81(Feb. 1969).

The record keeping system for personnel exposure to radiation should stress the retention of that data used in the evaluation of radiation dose where key factors that affect the dose number derived are subject to individual interpretation; the identification and qualifications of those individuals responsible for dose evaluation and the recording of the data associated with it; and a time of retention based on the applicable statutes of limitation, which, for practical purposes, appears to be commensurate with life expectancy rather than with tenure of employment or the duration of the exposure. (auth)

31811 RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION FOR RADIATION PROTECTION: REPORT OF COMMITTEE III ON PROTECTION AGAINST X RADIATION WITH ENERGIES UP TO 3 MeV AND BETA AND GAMMA RADIATION FROM ENCLOSED SOURCES. Schriftenr. Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 30, 1-80(1967). (In German).

Codes of practice for protection against x radiation with energy up to 3 MeV and β and γ x radiation from sealed sources are presented. The organ and tissue dose in rad or rem was regarded as equal to the radiation dose in R measured in air. The concepts used in radiation protection are defined. Testing and monitoring methods for radiation sources are given. Recommendations are made on the radiation installations and operational conditions. (J.S.R.)

31812 INFLUENCE OF BODY BURDEN OF RADIOMERCURY ON RADIATION DOSE. Phillips, R.; Cember, H. (Northwestern Univ., Evanston, Ill.). J. Occup. Med., 11: 170-4(Apr. 1969).

The results of this study support the postulate that there may be a class of elements (of which mercury is an example) for which the ICRP assumptions of an elimination rate that is independent of body burden and a fixed deposition percentage are not valid. The specific activity of the isotope must be considered when calculating the maximum allowable concentration and maximum body burden of radioactive mercury. (auth)

31813 CURIE AND THE ROENTGEN AS LEGAL UNITS OF MEASUREMENT. Richardson, J. F. (Commonwealth X-Ray and Radium Lab., Melbourne). Australas. Radiol., 13: 103-6 (Feb. 1969).

The development of the curie and the roentgen as recommended units of measurement of activity and exposure and their later adoption in Australia as legal units, in force 1st January 1966, are outlined. The present allocation of responsibility for maintenance of Australian standards of activity and exposure is outlined. (Australia)

31814 SOME THOUGHTS ON THE QUESTION OF RESPONSIBILITY FOR RADIATION PROTECTION IN DIAGNOSTIC RADIOLOGY. Tolan, J. H. (Univ. of Missouri, Columbia). Health Phys., 16: 395-403(Mar. 1969).

Reference is made to recent discussions concerning excessive exposure of patients to radiation during diagnostic examinations. While this finding is probably true, the author contends that certain fundamental issues have been overlooked in such discussions, and the purpose of the present communication is to direct attention to these issues in an effort to bring an appropriate perspective to the discussions. Issues discussed include vested interests, basic responsibility, knowledge of the health physicist on the subject, role of the x-ray technician, etc. It is considered that licensing of x-ray technicians as a means to prevent the current state of affairs is of itself a myth. The physician is the responsible party and the only person over whom regulatory control can be effective. Standards for determining proper qualifications should reside with the medical community, unless a federally regulated, minimum standard of qualification can be legislated. Regulatory control in general is discussed; also training of health physicists, and relevant research in this field. (UK)

31815 ANALYTICAL X-RAY HAZARDS: A CONTINUING PROBLEM. Lubenau, Joel O.; Davis, Jordan S.; McDonald, Donald J.; Gerusky, Thomas M. (Pennsylvania Dept. of Health, Harrisburg). Health Phys., 16: 739-46(June 1969).

Users of analytical x-ray equipment comprise 1.8% of the 7500 users of ionizing radiation in Pennsylvania excluding Philadelphia. Since 1956, the Pennsylvania Department of Health has learned of 29 workers who suffered acute accidental exposures to external radiation sources requiring medical attention. Of these, 22 individuals (76%) were exposed to analytical x-ray sources. In 1966 the Pennsylvania Department of Health initiated an extensive study of analytical x-ray users. An earlier study was conducted in 1961. Both studies were promoted by the continued heavy contribution of this group to the accidental exposure history in Pennsylvania. Efforts were made to establish the hazards peculiar to this group and to determine what steps could be taken to improve radiological safety. Recommendations, reflecting the results of the study and practicality of application, were issued to analytical x-ray users in Pennsylvania. (auth)

31816 RADIOBIOLOGICAL PROBLEMS ASSOCIATED WITH ADJUDICATION OF WORKMEN'S COMPENSATION CLAIMS.

Sagan, L. A. (Palo Alto Medical Clinic, Calif.). J. Occup. Med., 11: 335-9(June 1969).

Recent concepts emerging from current experimental radiobiology are reviewed, and their relation to the problem of assessing the etiologic role of occupational radiation exposure in human disease is examined. The adjudication of compensation in the case of acute radiation effects usually creates no problem for the traditional compensation system. In the case of late radiation effects, however, establishment of the causal relation between occupational radiation exposure and the alleged injury requires consideration of certain criteria including: establishment of extent of exposure and relation to development of disease; sensitivity of claimant to effects of radiation; potentiating or synergistic effects of other factors in claimants environment; and consideration of sources of exposure other than work environment. The problem of establishing a one cause-effect relation in disease is that for any given disease, the whole environment influences the development of the disease. A proposal is made for the establishment of a contingency fund for radiation workers. (E.R.B.)

31817 AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND AND THE GOVERNMENT OF THE REPUBLIC OF FINLAND FOR CO-OPERATION IN THE PEACEFUL USES OF ATOMIC ENERGY (WITH EXCHANGE OF NOTES, HELSINKI, MAY 24th, 1968. Treaty Series No. 43 (1969) (Finland). Cmnd. 3872. London, Her Majesty's Stationery Office, 1969. 16p. 2s.

This agreement entered into force on Feb. 20, 1969. The document supersedes "Finland No. 1 (1968)," Cmnd. 3761. (UK)

Medicine

Protective Substances

Refer also to abstracts 31646, 31650, 31917, 31944, 31991, 31997, 31998, and 32001.

31818 (AD-677924) ANALYSIS OF THE RADIATION-INDUCED LOSS OF TESTES WEIGHT IN TERMS OF STEM CELL SURVIVAL. Krebs, John S. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 18, 1968. 22p. (USNRDL-TR-68-104). CFSTI.

The proportion of radiation-insensitive tissue in the testes of the C57L mouse was determined to be 36.9% of the normal non-irradiated testes weight. The weights of testes of these mice at 28 days after various doses of irradiation were analyzed by subtracting out the radiation-insensitive weight and calculating the surviving fraction (S/So) of radiation-sensitive weight. The logarithm of S/So could be fitted linearly to the radiation dose, indicating an exponential tissue-loss process with a D37 for 250 kVp x rays of 78.9 rad. The D37 for testes weight loss from fission-neutron irradiation was 21.0 rad, indicating a relative biological effectiveness ratio for fission neutrons of 3.75. Treatment of mice with AET 15 minutes before irradiation with x rays increased the D37 to 119.6 rad, indicating a protection ratio of 1.5 for AET. Treatment of mice with Piromen (pseudomonas polysaccharide) 24 hours before irradiation had no effect on the D37 for testes weight loss. Irradiation with x rays at 2.8 R/min gave the same D37 for testes weight loss as irradiation at 14 R/min. The data indicate that loss of weight of the testes after irradiation reflects the survival curve of the germinal cell layer of the testes. (auth) (USGRDR)

31819 (COO-78-200) ANNUAL REPORT FOR PERIOD ENDING APRIL 30, 1969. Friedell, Hymer L. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Radiology). May 15, 1969. Contract W-31-109-eng-78. 25p. Dep. CFSTI.

The x-radiosensitivity of cultured L cells and Chinese hamster ovary cells was found to be greatly enhanced by the addition of 2-deoxyglucose. Mechanisms involved in this effect were investigated using 2-deoxyglucose to impair glycolysis before, during, and after exposure of cells to various doses of x radiation. Survival based on colony formation was used as the criterion. The effects of adding normal and dialyzed fetal bovine serum to the growth medium on cellular response to 2-deoxyglucose were also studied. X-radiosensitivity of partially-synchronized Ehrlich ascites tumor cells was investigated in mice administered methotrexate eight or 12 hr prior to exposure to 1100 R or eight or 12 hr prior to transfer of tumor cells to a new host. Tumor growth was assessed by comparing body weight of tumor-bearing animals to that of non-tumor bearing mice. Untreated tumor cells enlarged rapidly and resulted in death of the animal within 1 to 3 weeks; the growth of tumors from methotrexate-treated hosts was somewhat slower, while the growth of tumors in x-irradiated methotrexate-treated mice was extremely slow, and tests for ascites tumors were negative at 30 days in over 50%. Synthesis of mitotic DNA was investigated in relation to radiosensitivity of Physarum polycephalum exposed to fractionated doses given 1 to 2 hr apart. (C.H.)

31820 ANTIMETABOLITES IN THE TREATMENT AND PROPHYLAXIS OF RADIATION SICKNESS. Danysz, A.; Kocmierska-Grodzka, D.; Panek, R.; Matzkovyak, I. (Medical Academy, Belostock, Poland). Med. Radiol., 13: No. 12, 3-9 (Dec. 1968). (In Russian).

Anabolizing agents (anabolic androgens) exerted a radioprotective effect, augmenting the survival percentage in irradiated rats and significantly inhibiting the appearance of a number of postradiation changes. The radioprotective action of these preparations apparently depended on tissue hypoxia and weakening of postradiation changes in the synthesis of proteins and nucleic acids. Inhibitors of proteolytic enzymes (antifibrinolytics) in prophylactic and therapeutic, as well as only in therapeutic use after irradiation significantly increased the number of surviving animals, inhibiting the postradiation activation of proteolytic enzymes and the formation of some radiotoxins. (auth)

31821 EFFECT OF RADIOPROTECTIVE AGENTS ON ERYTHROPOIESIS IN IRRADIATED MICE. Vittorio, P. V.; Watkins, E. A.; Dziubalo-Blehm, S. (Defence Chemical, Biological, and Radiation Establishment, Ottawa). Can. J. Physiol. Pharmacol., 47: 65-71(Jan. 1969).

The radioiron test (i.e., ^{59}Fe uptake by blood, spleen, and liver) was used to evaluate the degree of protection (one day after irradiation) and effect on recovery (seven days after irradiation) of the erythropoietic system when radioprotective agents were administered. In blood, spleen, and liver, AET administered prior to irradiation caused a decreased radiation on ^{59}Fe uptake one day after irradiation, and a subsequent parallel return with the irradiated nonprotected group to the control value. This indicated that the early recovery by the protected group was probably due to less initial damage. The amount of protection afforded the erythropoietic system by sulfhydryl agents was in good agreement with irradiation survival studies and indicated that a good sulfhydryl radioprotective agent provided good protection, and a poor sulfhydryl radioprotective agent provided poor protection to the erythropoietic system. Thus the radioiron test is a good method to evaluate sulfhydryl compounds as radioprotective agents. Endotoxin demonstrated poor correlation between the early (one day) erythropoietic effect and survival in irradiated mice, but recovery studies (seven days) showed much better agreement. Serotonin produced poorer initial protection to the erythropoietic system and slower recovery than AET even though the dose reduction factor of each was comparable. Serotonin must, therefore, protect other systems which then contribute to the eventual recovery of the erythropoietic system and to survival. (auth) (Canada)

31822 PROTECTION IN THE ACUTE RADIATION SYNDROME. I. COMPARATIVE STUDY OF THE PROTECTION OBTAINED WITH NUCLEOPROTEINS AND WITH MARROW CELLS IN A HETEROLOGOUS SYSTEM. Nicolau, C. T.; Iercan, E.; Apateanu, V.; Marcu, I. (Center of Hematology, Bucharest). Doc. Haematol. (Bucharest), 1: 51-60(1967). (In Rumanian).

Biochemical methods of protecting animals during the acute radiation syndrome were observed and compared. Three groups of mice (100 in each) were irradiated with differing doses of x rays, 500, 600, and 700 R. Nucleoproteins and bone marrow cells, both intact and nonviable, were obtained from rats and used for protection. It was found that nucleoproteins (containing RNA, DNA, and proteins) from rat spleen and liver had a protective effect on hematopoiesis in irradiated mice. Protection increased with the amount of heterologous nucleoproteins administered and was greater when the dose was 10 mg/Kg of body weight than with smaller doses. Mice irradiated with 700 R were not as effectively protected by heterologous nucleoproteins as were mice receiving only 500 or 600 R. Such protection did not induce histologically detectable immunologic (graft vs host) lesions, whereas marrow cell protection, either intact or nonviable, did cause such lesions in spleen and lymph nodes. In animals protected by heterologous nucleoproteins, determinations of the leukocyte alkaline phosphatase demonstrated that the mechanism of this type of protection was not accompanied by changes at the cellular level in this enzyme. (BBB)

31823 ENHANCEMENT OF MURINE ASCITES TUMOR CELL KILLING WITH X-IRRADIATION BY THIOL BINDING AGENTS. Moroson, H.; Schmid, M.; Furlan, M. (Sloan-Kettering Inst. for Cancer Research, Rye, N. Y.). Radiat. Res., 36: 571-9(Dec. 1968).

Female mice bearing the Ehrlich carcinoma or P388 lymphocytic leukemia tumors in ascites form were given sublethal doses of whole-body x-irradiation and the thiol binding agents N-ethylmaleimide, hydroxymercuribenzoate, or iodoacetamide, injected intraperitoneally prior to irradiation, as a single treatment. These

compounds were found previously to sensitize mice to radiation lethality. Enhanced tumor cell killing was observed as measured by tumor cell count, along with slightly longer survival times of the host animal. Increasing the dose of either radiation or drug alone also caused an increase in tumor cell killing, but at the expense of earlier mortality of the host animal. At the doses employed the sensitizers examined appeared more effective on these two ascites tumors than on the host. The mechanism of enhancement of radiation killing of tumor cells by these drugs is not clear, although it appears not to be due to additive toxicity effects. Similar experiments with several cancer chemotherapy agents showed that those compounds did not act as radiosensitizers. (auth)

31824 VALUE OF CHEMICAL MIXTURE IN MULTIPLE SUPRALETHAL X-IRRADIATION OF MICE. Wang, Richard I. H.; Hasegawa, A. T. (Veterans Administration Center, Wood, Wis. Marquette School of Medicine, Milwaukee). Radiat. Res., 36: 254-60(1968).

A chemical mixture containing 25 μmoles of MEA, 7 μmoles of AET, and 2 μmoles of 5-HT was found to be of significant value in protecting mice against repeated exposures of 800 R, 1100 R, or 1400 R given at intervals of 28 days. Dose-reduction factors of 2.17, 2.18, 1.95, 2.14, and 1.58 were obtained for the first five exposures. Following the first exposure there was no chemical mortality. The beneficial value of this mixture, however, was limited by the incidence of chemical toxicity that was more prevalent in mice with higher cumulative doses of radiation. (auth)

31825 EFFECTS OF SOME DRUGS ON RECOVERY FROM RADIATION DAMAGE. Kawasaki, Shoji; Sakurai, Ko (Yamaguchi Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1375-8(Jan. 1969). (In Japanese).

The effects of vitamin B group, nucleoside, and nucleotide on recovery from radiation damage were observed. The compounds were administered intraperitoneally to mice in aqueous solution. The increase of survival time of repeatedly irradiated mice (300 R, 200 KVp x ray, once per week until the death of animals) was observed with the use of vitamin B group and ATP at 1 and 4 days after every exposure. Reduction in body weight after irradiation was restored with the same compound. With the use of inosine and other nucleotides the effect was not observed. (NSA of Japan)

31826 CYSTEINE PROTECTION AGAINST THE MORPHOLOGIC EFFECTS OF X IRRADIATION ON MOUSE SPLEEN. Bari, W. A. (Washington Univ., St. Louis). Pathol. Microbiol., 32: 205-18(1968).

The protective action of cysteine against whole-body x irradiation was studied in mice as well as its distribution within the various organs of the body. Adult male Swiss mice weighing 20 to 30 g were given 1 to 5 mg/g body weight of L-cysteine-HCl. The cysteine was given 10 and 30 min, 1 hr and 3 hr before and after an $LD_{50/30}$ dose of whole-body x irradiation (750 R). The mice were killed 6 hr following irradiation, and tissue from spleen was processed for light and electron microscopy. Other mice were injected intraperitoneally with L-cysteine-^{35}S (20 μCi/g body weight) to study the localization of cysteine within various organs. Cysteine administered orally and subcutaneously prior to irradiation showed significant protection against acute radiation effects in splenic lymphocytes. There was a marked reduction in the number of damaged lymphocytes. This protection increased with increasing the dose of cysteine up to 3 mg/g body weight. Cysteine was highly toxic when injected intraperitoneally and the mice died within 30 min after injection. Cysteine-^{35}S showed localization mainly within the crypts of Lieberkuehn of the small intestine and in the hair follicles. No clear correlation was found between localization of cysteine-^{35}S in the spleen and its radioprotective effect. Possible mechanisms of action of cysteine as a radioprotector were discussed. (BBB)

31827 EFFECT OF PHYTOHEMAGGLUTININ ON THE LEUKOCYTE COUNT IN RATS. Robinson, E. (Hebrew Univ., Jerusalem). Vox Sang., 13: 467-71(1967).

The effect of phytohemagglutinin (PHA), an extract of the kidney bean Phaseolus vulgaris, on the leukocyte count in normal and irradiated rats was studied. Total-body x irradiation of 500 R was given 24 hr after PHA injection at a dose rate of 130 R/min. In nonirradiated rats the number of leukocytes decreased 1 hr after PHA injection and then gradually rose to a peak 4 hr after the injection. Differential leukocyte counts suggested that the rise was due to a relative increase in neutrophils. The total leukocyte count then gradually fell and on the third day after the PHA injection became stable. The leukocyte counts of the irradiated, PHA-treated rats were compared with that of an irradiated-only group. At 24 hr after PHA injection a significant rise in the leukocyte count was found. Total-body irradiation to 500 R was then administered; the fall in the leukocyte count was greater in the PHA-treated than in the untreated animals. The subsequent increase in the leukocyte count was followed at intervals up to 4 months. It was found that in PHA-treated, irradiated rats the increase in the leukocyte count was statistically significantly greater than in the irradiated untreated group. On the 16th day after irradiation a second dose of PHA was injected. Since no leukocyte reserves exist in irradiated animals, no initial rise in the leukocyte count was seen. The results indicate that PHA has a two-fold effect on the leukocyte count. At first it liberates leukocytes from the reserves as is seen in the early rise 4 hr after injection. The second effect is stimulation of leukopoiesis as indicated by the persistence of the high count in nonirradiated rats, and by the greater increase in the leukocyte count after irradiation in PHA-treated animals. Both these phases were seen in normal and irradiated rats. (BBB)

31828 EVALUATION OF THE ACTUAL STATE OF THE RESEARCH IN THE FIELD OF RADIOPROTECTIVE DRUGS. Danysz, A. (Medical Academy, Bialystok, Poland). Pol. Tech. J., 12: 89-99(1968). (In Polish).

Properties of ideal radioprotective drugs are discussed and the most effective drugs are listed. Disadvantages of radioprotective drugs known at present are low effectiveness and high toxicity. Experiments on patients with tumors and healthy volunteers subjected to γ and x ray therapy revealed that the effectiveness of radioprotective drugs was related to the radiation dose and manner of administration. Studies on the mechanism of chemical radioprotection led to the conclusion that there is no one radioprotective substance that can be used as a safe, effective drug in man. The importance of further investigations on the mechanism of radioprotection is emphasized. (NSA of Poland)

Radiation Sickness and Injuries

31829 BEITRAG ZUR CHIRURGISCHEN VERSORGUNG RADIOAKTIV KONTAMINIERTER WUNDEN. (Contribution of Radioactive Contaminated Wounds to Surgical Supplies). Ohlenschlaeger, Lothar. Schriftenreihe Arbeitsmedizine, Sozialmedizin, Arbeitshygiene, Band 24. Stuttgart, A. W. Gentner Verlag, 1968. 32p.

Treatment of radioactive contamination of wounds is described. The basic treatment is divided into three phases. The first treatment occurs at the accident site by trained or untrained laymen. The first medical care takes place in a specially outfitted ambulance. Additional treatment of the severe cases occurs in a special clinic. Of the 101 persons with wounds examined in the years from 1964 to 1966, 19 (about 18.9%) of the wounds were contaminated. Five (about 5%) had activity exceeding the detection limits of the measurement device. By excision of the wound lip the activity could be eliminated in all cases. Activation analysis of the excised wound tissue and venous blood and of the 24-hr urine was carried out in addition to the routine measurement of the excised tissue. (tr-auth)

31830 TOPICAL 5-FLUOROURACIL IN THE TREATMENT OF ACTINIC KERATOSES: CASE REPORTS. Hueser, James N.; Strand, Martin E.; Pugh, Reginald P. (Univ. of Missouri, Columbia). Missouri Med., 65: 965-8(Dec. 1968).

A description is given of experience in treating 24 patients with severe radiation-induced keratoses utilizing topical chemotherapy with 2% topical 5-fluorouracil (5-FU) as the chemotherapeutic agent. Persons with sun-damaged skin and actinic keratoses are likely to develop cancers of the skin. The major side effect of topical 5-FU was an inflammatory response which may be used as an end point of active treatment. The drug had a selective action on actinic keratoses, resulting in their disappearance. In present series, application of a 2% 5-FU ointment resulted in disappearance of most actinic keratoses, although one lesion persisted after treatment in each of the 2 cases presented. The appearance of new lesions after treatment with 2% ointment has not been frequent. When recurrences did occur, retreatment usually resulted in the disappearance of the new lesions. Actinic keratoses on the face and neck were much more sensitive to 5-FU than those occurring on the hands and arms. (BBB)

Radiodiagnosis

Refer also to abstracts 31622, 31763, 31798, 31973, and 31981.

31831 (CNEA-237) MACROAGGREGATES OF HUMAN ALBUMIN WITH ^{113m}In FOR LUNG SCINTISCANNING. Ciscato, Valentin A.; Nicolini, Jorge O.; Palcos, M. Cristina (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 14p. (In Spanish). Dep.

A technique is described for the preparation of human serum albumin macroaggregates that can be labeled with ^{113}In for use in lung scintiscanning. Particle sizes range from 10 to 150 μ. The labeling technique is simple and requires 10 minutes. The final preparation is sterilized by autoclaving. Distribution studies in

rats showed a retention in the lungs of over 90% of the radioactivity 30 minutes after the intravenous injection. (auth)

31832 (CONF-670649-5) TEACHING OF NUCLEAR MEDICINE. Ortiz Berrocal, J. (Clinica Puerta de Hierro, Madrid (Spain)). [1967]. 5p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The definition of nuclear medicine is given and the necessity of its separation as a medical specialty, recognized by the Medical Specialist Law, is discussed. The separation of the fields corresponding to nuclear medicine and related disciplines is suggested. The teaching of nuclear medicine can be carried out as an interlocking discipline with fundamental science, as part of the training of specialists in radiology, and as basic discipline for specialists in nuclear medicine. Scholastic periods and programs for the development of specialists in this area in Spain are proposed according to the orientation adopted. (tr-auth)

31833 RADIOACTIVE IRON IN HAEMATOLOGICAL DIAGNOSIS: INDICATIONS AND RESULTS. Montz, R. (Univ., Hamburg). Deut. Med. Wochenschr., 94: 1076-8(May 16, 1969). (In German).

Radioactive iron-59 is the ideal substance for diagnostic studies in hematology. It is especially useful in the evaluation of bone marrow and spleen activity and provides basic information about the pathogenesis of anemia and erythrocythemia. (H.B.G.)

31834 USE OF THE SCINTILLATION CAMERA FOR ROUTINE DIAGNOSIS IN NUCLEAR MEDICINE. Marczinkowski, N.; Wuerthner, Kl. (Staedtische Rudolf-Virchow-Krankenhauses, Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 99-107 (Jan. 1969). (In German).

The use of the scinti-camera Pho/Gamma III for total localization of isotopes for clinical studies is described and illustrated by examples. The camera is technically sufficiently advanced to offer certain advantages not found when scintillation scanners are used. (auth)

31835 VALUE OF INFUSION UROGRAPHY AND ISOTOPE NEPHROGRAPHY FOR DIAGNOSIS OF INFECTIONS OF THE URINARY TRACT OF CHILDREN. Preuss, H.-J.; Deckart, H. (Staedtische Klinik, Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 39-48(Jan. 1969). (In German).

The results of infusion urography (using Visotrast-290) and isotope nephrography using ^{131}I hippuran on 190 children between two month and 14 years are reported. These children were treated in hospital or as out patients for urinary tract infections or pyelonephritis. Agreement was found in 81.5%, in 7.8% abnormal radiological findings were associated with a normal isotope nephrogram, whereas in 10.5% an abnormal nephrogram was associated with normal radiographic findings. The severity of the process and morphological and functional recovery can only be evaluated by taking the clincal findings into account. Combined, the two methods produce correct results, but a normal isotope nephrogram does not exclude the need for a radiological examination. (auth)

31836 USE OF ^{197}Hg-CHLORMERODRIN FOR SCINTIGRAPHY OF BRAIN OF CHILDREN. Lincke, H. O. (Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed., 110: 16-28(Jan. 1969). (In German).

Cerebral scintigrams using ^{197}Hg chlormerodrin were carried out in 71 children. In 26 children the results could be verified; in nine they were not completely verified, but space occupying lesions were demonstrated by means of other neuroradiological procedures. Scintigraphy provides valuable information for the presence of space-occupying lesions during childhood, particularly for tumors in the posterior fossa, which are common at this age. The type of tumor cannot be diagnosed by the scintigram, but it was noted that very marked activity is common in cerebellar astrocytomas and supra-tentorial spongioblastomas. On the other hand medulloblastomas, the commonest malignant tumor during childhood, shows increased activity in only about half the cases. Tumors of the pons generally show no increased activity. Although the method is at present not sensitive enough for the early diagnosis of space-occupying lesions in childhood, it is nevertheless useful, since in combination with angiography it may reduce the frequency of more complex examinations, such as ventriculography, without adding greatly to the amount of radiation. (auth)

31837 X-RAY AND ISOTOPE DIAGNOSIS OF THE PANCREAS. van de Weyer, K. H. (Univ., Mainz). Therapiewoche, 19: 553-60(Mar. 19, 1969). (In German).

In the diagnostic study of the pancreas, conventional roentgenologic procedures are necessary but frequently indecisive. Scans with selenium-75 as a labeled methionine also are unsatisfactory in a large number of cases. Catheterization of the coeliac artery, followed by injection of a contrast medium, leads to a good presentation of the pancreatic vascular system and, therefore, appears to be the most promising procedure for the detection of even small tumors. (H.B.G.)

31838 USE OF RADIOSTRONTIUM IN THE SCINTIGRAPHY OF PAGET'S OSTEODYSTROPHY. Tori, G.; Marabini, A.; Cabassa, N.; Giaretta, V.; Tognetti, G. P.; Tison, V.; Mazzanti, G. L. (Univ., Bologna). Radiobiol. Radioter. Fis. Med., 23: 237-68(July-Aug. 1968). (In Italian).

Seven cases of Paget's osteodystrophy, two of which were the monostotic type and five of polyostotic type, were studied. The importance of bone scanning with radiostrontium for the study of this osteodystrophy is discussed, not so much from the diagnostic point of view as for the possibilities it offers compared with the radiological examination for an evaluation of the degree and evolution of the disease. The fibro-osteoid lesions are generally characterized by a high uptake of the radionuclide, while in lesions with less definite evolution a lower accumulation pattern or a dishomogeneous appearance is obtained. The phase of calcium turnover is practically absent, which corresponds for example to a radiological picture of osteosclerosis of the flat bones of the skull. These findings were substantiated by histological investigation made on bone lesions of different evolution. (C.O.)

31839 THE SIGNIFICANCE OF SCANNING TECHNIQUES IN TB LOBITIS. Bignamini, A.; Temporelli, A. (Ospedale San Luigi Gonzaga, Turin). Minerva Med., 60: 1123-9(Mar. 28, 1969). (In Italian).

Scintigraphic and pulmonary artery circulation scanning techniques were used in the diagnostic and prognostic evaluation of tubercular lobitis. For this purpose, macroaggregates of human albumin labeled with ^{131}I were employed. It is considered that isotope methods form a useful diagnostic adjunct to tomography, bronchography, and pneumo-angiography. (auth)

31840 EXPERIMENTAL MODEL TO STUDY PULMONARY MICROEMBOLISM. James, A. Everette Jr.; Eaton, S. Boyd; Page, David L.; Potsaid, Majic S.; Fleischner, Felix G. (Massachusetts General Hospital, Boston). Radiology, 92: 924-7 (Mar. 1969).

In patients with pulmonary microemboli, lung scintigrams obtained by using the gamma camera have shown a circumferential zone of diminished radioactivity in the periphery of one or several lobes. This peripheral border of diminished activity on the scintigram is postulated to represent decreased perfusion which results from microemboli lodging in small peripheral pulmonary arteries. The mechanism for circumferential diminished perfusion was investigated in large mongrel dogs. The effects of intravenous administration of polystyrene microspheres from 1 mm to 0.147 mm in diameter, followed at projected time intervals (several minutes to two weeks) by ^{131}I-macroaggregated albumin were followed by pulmonary radiographs and photoscintigraphs. The animals were sacrificed, and the heart and lungs were removed intact. The pulmonary arteries were injected with a modified Schlesinger mass and the lungs were inflated with 20% formalin. Radiographs of the injected lungs were then obtained. The radiographs of the injected specimens demonstrated why the radioactivity does not reach the periphery of each lobe via the pulmonary arteries. Those animals in which the microspheres were injected did not have filling of the peripheral branches with the modified Schlesinger mass as in the animal without microspheres. The effect of pulmonary microemboli appears to be primarily mechanical vascular obstruction although the role of arteriolar vasoconstriction and bronchial collaterals has not been defined. (C.H.)

31841 PULMONARY SCANNING IN BRONCHOGENIC CARCINOMA. Maynard, C. Douglas; Miller, Robert P.; Heaphy, Leo J. Jr.; Whitley, Joseph E. (Wake Forest Coll., Winston-Salem, N. C.). Radiology, 92: 903-7(Mar. 1969).

After analysis of 50 cases of bronchogenic carcinoma with comparison of the perfusion lung scan, routine chest roentgenogram, and surgical findings, the following conclusions were drawn: The changes observed on the lung scan are frequently of a greater magnitude than those observed on routine chest films; in general, hilar lesions produce greater changes on the scan than do the peripheral ones; except in isolated cases lung scans will probably be of little value in the early diagnosis of lung cancer; the classification of lung cancer as either resectable or nonresectable on the basis of the scan findings is not justifiable; lung scans may be of value in following the response of tumors to chemotherapy and/or radiation therapy; and the full value of the lung scan in the work-up of bronchogenic carcinoma is not known at this time. Further investigation is necessary to clarify its usefulness in the evaluation of this disease. (auth)

31842 "RADIOISOTOPE ARTERIOGRAPHY" AS AN ADJUNCT TO THE BRAIN SCAN. Maynard, C. Douglas; Witcofski,

Richard L.; Janeway, Richard; Cowan, Robert J. (Wake Forest Coll., Winston-Salem, N. C.). Radiology, 92: 908-12(Mar. 1969).

Rapid serial anterior scintiphotographs as an adjunct to the routine brain scan (employing ^{99m}Tc pertechnetate and the Anger camera) were obtained in over 1,000 patients. This type of study (radioisotope arteriography) provides complementary information rapidly without increased morbidity to the patient. Its value is in localizing lesions not visualized by routine scans and allowing categorization of most positive scans. (auth)

31843 ^{99m}Tc SUPERIOR VENA CAVOGRAPHY. Maxfield, William S.; Meckstroth, George R. (Charity Hospital, New Orleans). Radiology, 92: 913-17(Mar. 1969).

There was accurate correlation between the findings on ^{99m}Tc superior vena cavography and clinical symptoms in 20 patients with blockage of blood circulation in the brain and between the findings of these two procedures and those of venous angiography in the 10 patients undergoing all three examinations. Venous angiography is indicated for precise determination of the anatomical site and the pattern of blockage in patients with obstruction of the superior vena cava, while ^{99m}Tc vena cavography is strongly recommended as a screening procedure and for follow-up studies. (auth)

31844 RAPID, SEQUENTIAL RENAL BLOOD FLOW SCINTIPHOTOGRAPHY. Freeman, Leonard M.; Meng, Chien-hsing; Bernstein, Robert G.; Blaufox, M. Donald (Yeshiva Univ., Bronx, N. Y.). Radiology, 92: 918-23(Mar. 1969).

Rapid, sequential scintiphotographic techniques using ^{197}Hg- or ^{203}Hg-labeled chlormerodrin or ^{99}Tc-labeled pertechnetate and a γ camera may be used for the visualization of renal blood flow. The potential applicability of this examination in several types of renal disease has been studied and is described. As with other studies using isotopic organ visualization, this procedure is meant to complement and not compete with currently available radiographic technics such as intravenous urography and renal angiography. Only further investigative work will determine exactly what diagnostic niche this procedure will occupy in relation to radiographic studies of the kidney. Future improvements in instrumentation will allow greater resolution, and the increased usage of digital data will also enhance the value of isotopic procedures such as the one currently described. (auth)

31845 THE SIGNIFICANCE OF EXPOSURE PARAMETERS IN DENTAL RADIOGRAPHY. Webber, Richard L.; Ryge, Gunnar Oral Surg., Oral Med., Oral Pathol., 27: 740-53(June 1969).

Diagnostic potential of dental radiographs obtained from conventional sources is relatively independent of beam quality as determined by changes in aluminum filtration and peak kilovoltage. The slight differences in diagnostic potential that do result when these parameters are varied are not uniform for different tissues but can be accurately predicted from slope measurements of H and D curves obtained under conditions identical to those encountered clinically. A substantial increase in diagnostic potential is realized when exposures are chosen that maximize the slope (gamma) of an H and D curve plotted from data obtained under clinical conditions. The half-value layer is unreliable as an indicator of diagnostically significant characteristics of broad-spectrum x radiation. Diagnostic information is maintained while dose is minimized when the radiation used has a spectral band width only slightly larger than that range of energies barely capable of penetrating the structures to be diagnosed. (auth)

31846 SERIAL BRAIN SCANNING WITH ^{99m}TECHNETIUM PERTECHNETATE IN CEREBRAL INFARCTION. Usher, Michael S.; Quinn III, James L. (Northwestern Univ., Chicago. Chicago Wesley Memorial Hospital). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 728-33(Apr. 1969).

The serial scans and case histories of 28 patients with cerebral infarction were reviewed. The correlation of changing scan patterns with clinical course was a useful guide to prognosis. Scan area and density alone were of limited value. It is recommended that a scanning be performed as soon as possible after the onset of symptoms as a baseline, 7 to 10 days later for diagnosis, and at 3 to 4 weeks for prognosis. (auth)

31847 FLUORESCENT THYROID SCANNING. Hoffer, Paul B. (Univ. of Chicago). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 721-7(Apr. 1969).

A system was developed for the demonstration of in vivo stable ^{127}I within the thyroid gland. This system has the following desirable characteristics: No radioactive isotope is administered to the patient; the radiation dose to the thyroid gland is low (less than 500 millirads); the system visualizes all iodine within the gland regardless of the metabolic status of the region in which it is located. For example, when used in conjunction with conventional scanning, fluorescent scanning can delineate the iodine content of cold nodules. Hopefully, in some cases, this will permit etiologic identification of such lesions; and the unit may be conveniently used in conjunction with the electronics of commonly available rectilinear scanners. The clinical usefulness of this system is promising, but awaits further investigation. In addition, preliminary information is presented demonstrating the use of fluorescent scanning for laminographic applications and imaging nonradioactive tracers in vivo. (auth)

31848 LIPID EMBOLISM TO THE BRAIN FOLLOWING LYMPHOGRAPHY. CASE REPORT AND EXPERIMENTAL STUDY. Davidson, J. W. (Ontario Cancer Inst., Toronto). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 763-71 (Apr. 1969).

The clinical, laboratory, and roentgenographic findings in a patient with cerebral complications following lymphography performed after commencement of radiotherapy to the chest are described. A preliminary experiment to examine the possibility that external irradiation may influence the filtration mechanism in the lungs of rabbits for ultrafluid lipiodol injected intravenously, is recorded. (auth)

31849 KIDNEY INVESTIGATIONS WITH ^{131}I-LABELED-IODINATED AMIDE. Weissenstein, H.; Suetterlin, F.; Feller, E. (Central Hospital, Koblenz, Ger.). Radiologe, 9: 60-4(Feb. 1969). (In German).

Iodine-131-labeled Uromiro (diatrizoate sodium) is excreted exclusively by glomerular filtration; neither renal tubuli nor liver are involved. Because of its lack of damaging side effects, the compound appears to be a promising tool for evaluation of glomerular function. (H.B.G.)

31850 PRELIMINARY RESULTS OF THE ^{133}Xe EXPLORATION OF THE ARTERIAL VASCULARIZATION OF THE LEGS. De Roo, M.; Bossaert, H.; Amery, A.; Verstraete, M. J. Belge Radiol., 52: 52-8(1969).

The ^{133}Xe muscle blood flow measurements (rest muscle blood flow, muscle blood flow after ischaemic exercise, and latency time) can be considered as a valuable additional exploration method of the arterial vascularisation of the legs. These quantitative informations permit evaluation in an objective manner of the evolution of the disease or the effect of the therapeutic measures. (auth)

31851 A PROCEDURE FOR QUANTITATIVE DETERMINATION OF MINERAL CONTENT OF BONES WITH RADIOISOTOPES. PART I. SINGLE ISOTOPE METHOD. Strueter, H. D.; Rassow, J. (Ruhr Univ., Essen). Fortschr. Geb. Roentgenstr. Nuklarmed., 110: 499-506(Apr. 1969). (In German).

The usefulness of available methods for the early estimation of bone calcium loss is evaluated. The best method, with regard to ease of application and accuracy, is a new method using radioisotopes and a scintillation counter as detector. Initially an accurate, quantitative estimation of all possible sources of error was carried out. The results are shown in the form of diagrams and tables and permit rapid and exact estimation, without further calculations, of the accuracy, using any desired photon energy, activity (impulse frequency), and thickness of bone and skin. By this means optimal results are possible. The pre-supposition for the use of this method is an accurate correlation between reduction in beam intensity and mineral concentration. Energy discrimination of γ-quanta eliminates the effect of scatter. (auth)

31852 DUAL CHANNEL SCANNING. Kaplan, Ervin; Ben-Porath, Moshe (Veterans Administration Hospital, Hines, Ill.). Med. Clin. N. Amer., 53: 189-93(Jan. 1969).

Development of a dual channel scanning system utilizing ^{198}Au and ^{75}Se for diagnosis of pancreatic disorders is presented. The differential distribution of hepatic radiogold and hepatopancreatic ^{75}Se-selenomethionine is employed in the liver subtraction system. The patient is prepared for pancreatic scanning by intravenous injection of 100 μCi of ^{198}Au in colloidal suspension and 250 μCi of ^{75}Se-selenomethionine. One hour after injection the detector of the scintiscanner is placed over the right lobe of the liver in an area remote from the pancreas. The output of the detector is fed into 2 individual pulse height analyzer count rate meter systems. One is set to detect the 0.411-MeV ^{198}Au photopeak, the other the 0.280-MeV ^{75}Se photopeak. The deflections on the two count rate meters are adjusted so that the ^{198}Au and ^{75}Se deflections are equal. If the Au is presented as negative to the Se output, the sum of the 2 outputs is zero. The Se channel output will record only extrahepatic ^{75}Se activity, which is derived principally from the pancreas. The sum of the differences of the d-c outputs of the count rate systems is reconverted to pulses by a d-c to frequency converter. Depth discrimination using 2 isotopes and 1 probe is also considered. A modified system was developed for improvement of the dual channel scanner by enhancing storage, display, and analysis of the information detected. The discrimination of depth by color modulation and the depth of a specific concentration of γ-emitting

radioactivity in a patient is difficult to define in a 2-dimensional picture. (BBB)

31853 THE USE OF RADIONUCLIDES IN ORTHOPEDICS. PART IV. RADIONUCLIDE SCINTIMETRY OF THE SKELETON. Bauer, Goeran C. H. (Hospital for Special Surgery, New York). J. Bone Joint Surg., 50-A: 1681-1709(Dec. 1968).

Various aspects of use of radioisotopes in examination of the skeleton are reviewed (72 references), including techniques used, body retention of radionuclides, regional measurements of isotopes, radionuclide densitometry of bone, interpretation of data, total-body measurements, and reasons for selection of various nuclides (^{45}Ca, ^{46}Ca, ^{47}Ca, ^{48}Ca, ^{32}P, ^{22}Na, ^{24}Na, ^{87}Sr, ^{85}Sr, and ^{140}Ba). The use of radionuclides in 2500 examinations performed in orthopedic hospitals is referred to, with emphasis on the correlation of radionuclide scintimetry with clinical orthopedic problems. Examples of experiments in animals are furnished for clarification of observations in humans. Results have shown that radionuclide scintimetry provides a method for densitometry of the skeleton with higher precision than does roentgenography. First results of in vivo neutron activation analyses of human subjects indicate that it may become possible to determine the total-body Ca without exposing the patient to intolerably high dosage of radiation. (TSS) (BBB)

31854 ^{85}Sr SCANNING OF SUSPECTED BONE DISEASE. Parsons, Victor; Williams, Margery; Hill, David; Frost, Pamela; Lapham, Avril (King's Coll. Hospital, London). Brit. Med. J., 1: 19-23(Jan. 4, 1969).

Choice of radioisotopes for bone scanning is considered, advantages and disadvantages of each, as well as doses incurred, are discussed, and reasons for selection of ^{85}Sr for detection of bone lesions in 81 patients are given. The introduction of the short-lived cyclotron-produced isotopes ^{87m}Sr and ^{18}F increased the use of this technique. Large activities could be given to the patient, enabling the overall scanning time to be short and at the same time reducing the radiation dose by a factor of 200; the dose to bone with 500 μCi ^{87m}Sr is 200 mrad, while 70 μCi of ^{85}Sr gives 2.6 rad. There are, however, disadvantages associated with these short-lived isotopes. They cannot be stored for use on demand; they are produced only intermittently; the source of production must be close to their site of use; the scans must be made within hours of injection; and serial scans over days or weeks are impossible. In the case of a doubtful initial scan serial scans can be a valuable adjunct, as the uptake ratio of diseased to normal bone may increase over several days. Pelvic scans made soon after ^{18}F administration are complicated by high count rates over the renal tract which can obscure certain lesions, though fecal collection of ^{85}Sr provides a similar problem. In the studies on 81 patients described, about 1 μCi of ^{85}Sr/Kg was given intravenously as strontium chloride in aqueous solution. Detection of increased uptake over suspected lesions was made in one of two ways. A scintillation crystal-collimator assembly with a large field of view was used, and the total number of counts obtained in a fixed time at 5-cm intervals along the spine was recorded. Alternatively, a crystal-collimator assembly with a small field of view (1-cm circle) and designed to show maximum sensitivity to a source placed some distance in front of the system was used; the crystal-collimator assembly scans automatically over the spine. (BBB)

31855 SCINTIGRAPHIC, ANATOMIC, AND HISTOLOGIC FINDINGS FOLLOWING PARTIAL IRRADIATION OF THE LIVER WITH FAST ELECTRONS. Marczinkowski, Norbert (Rudolf-Virchow-Krankenhauses, Berlin). Strahlentherapie, 137: 267-76(Mar. 1969). (In German).

The effect of partial irradiation of the liver, with electrons from a betatron was studied with scintigraphy and histology. With 2000 rd tumor dose, cold zones can be seen on the scintigram with colloidal ^{198}Au gold and ^{131}I Rose Bengal and fibrosis on the histological preparations. The liver must be considered as radiosensitive as the kidneys. Recovery capabilities of the liver are reduced after moderate doses of 3000 to 4000 rd, because an almost irreversible fibrosis and even marked atrophy results from the irradiation. (auth)

31856 QUANTITATIVE DETERMINATION OF RADIOACTIVITY ON AUTORADIOGRAPHIC SECTIONS. Strolin-Benedetti, M. (Univ., Geneva). Experientia, 25: 558-9(May 15, 1969). (In French).

A method for the quantitative determination of radioactivity on autoradiographic sections by using the liquid scintillation counting technique is described. (auth)

31857 EXPERIMENTAL STUDY OF PERIPHERAL CIRCULATION AND BONE GROWTH. AN EXPERIMENTAL METHOD FOR THE QUANTITATIVE DETERMINATION OF BONE BLOOD FLOW. PART III. Ray, Robert D.; Kawabata, Masaya; Galante, Jorge (Univ. of Illinois, Chicago). Contract AT(11-1)-507. Clin. Orthop. Related Res., No. 54: 175-85(Sept.-Oct. 1967).

A method for the quantitative determination of bone blood flow based on Fick's principle using ^{45}Ca or ^{85}Sr was developed. The total activity in the bone was corrected for the activity present in the marrow vascular space at the time of sacrifice as determined by simultaneous injection of ^{51}Cr-labeled red cells. Calcium-45 clearance by bone was studied in dogs injected with 20 μCi of ^{45}Ca. The difference between arterial and venous concentration of ^{45}Ca was greatest during the first minute and then decreased slowly during the next 10 min. Clearance of the radioisotope was incomplete even for the first min. The average extraction ratio was 51.70% for the first 5 min and 45.36% for the first 10 min. Strontium-85 distribution in canine normal bone is also reported. Chromium-51-labeled red cells were injected into the jugular vein. Fifteen min were allowed to elapse for mixing, and then ^{85}Sr (15 to 20 μCi) was injected into the vein. Five min later one lower extremity was amputated, quickly frozen, and the femur was dissected. The bone was divided into three components: cortical bone, cancellous bone, and marrow. Each was ashed and counted for ^{85}Sr and ^{51}Cr separately. Cancellous bone accounted for 82.64% of the total uptake of isotope by bone, the values for cortex and marrow being 12.86% and 6.5%, respectively. Of the total blood volume in bone the cortical and cancellous fractions accounted for 88.46%, while only 11.54% was accounted for by the marrow. (BBB)

Radiotherapy

Refer also to abstracts 31567, 31660, 31669, 31746, 31748, 31767, 31768, 31782–31791, 31793, 31804, 31976–31978, 31980, 31981, 31983–31985, and 31988.

31858 (CNEA-216) EFFECTS OF RADIOCOLLOIDS ON SEROUS EFFUSIONS OF NEOPLASTIC ORIGIN. Dosoretz, Bernardo; Mugliaroli, Hugo A.; Mendez, Jorge (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 40p. (In Spanish). Dep.

Colloids of ^{198}Au were injected into the peritoneal or pleural cavity of patients effused by neoplasms. The techniques used are described, and data on the distribution of injected ^{198}Au colloids in the tissues are included. Clinical data are reported on a number of patients, some of whom showed a marked but relatively short-lived remission of effusions following the treatment. (C.H.)

31859 (CONF-681032-, pp 285-302) MEDICAL USE OF ^{252}Cf. Atkins, Harold L. (Brookhaven National Lab., Upton, N. Y.). (BNL-12919).

The development of encapsulated sources of ^{252}Cf suitable for interstitial application has provided a versatile tool for tumor therapy. These implantable sources are especially useful for certain applications, and have definite advantages over other sources of neutrons. The required amounts of ^{252}Cf are so small that the material can be electrodeposited on a very thin wire so that extreme flexibility in source design is possible. Some of the advantages of the ^{252}Cf sources include; cost, reliability, facilities and personnel required, and the existence of a higher LET and presumably lower OER than neutrons produced by accelerator reactions. Before a therapeutic trial with ^{252}Cf it will be necessary to determine the following; the RBE for this form of irradiation compared to more conventional forms, the effects of protracted versus acute irradiation, the tolerance dose for normal tissues, and the OER. Because of the need for implantation of the ^{252}Cf source, only those tumors which are accessible can be considered for irradiation. Investigations of the RBE, the LET, and the OER of ^{252}Cf are currently underway. (E.R.B.)

31860 RADIATION THERAPY OF ESOPHAGEAL CANCER. Sakai, Kunio; Hara, Keiji (Niigata Univ., Japan). Niigata Igakkai Zasshi, 82: 457-63(July 1968). (In Japanese).

Results are reported on 70 cases of neoplasms of the esophagus treated with fractionated doses of x radiation with total doses up to 5000 R. Primary healing of neoplasms was observed in approximately one third of the cases. The incidence of neoplasms of the esophagus as a factor of age and sex is discussed. (NSA of Japan) (TSS)

31861 RADIOTHERAPY OF CANCER OF THE PARANASAL SINUSES: A CLINICAL STUDY. Baba, Shunkichi; Ohashi, Michizo; Uchida, Toshio. Gan No Rinsho, 13: 1025-32(Nov. 1967). (In Japanese).

Treatment of the cancer of the paranasal sinuses is much less successful than in most other cases of cancer. A review is presented of radiotherapeutic investigations on paranasal sinus cancer carried out in Japan during the period from 1960 to 1964. A total of 65 patients including 35 males and 26 females were treated at the Nagoya City University Clinic and the Toyohashi Clinic.

These are classified according to age, site of attack and stage of the disease. The treatment consisted of irradiation by an x-ray machine, rotating ^{60}Co source, ^{60}Co beads, or 18-MeV betatron x rays. The dosage ranged from 6000 R to 14,000 R. The treatment is classified as: preoperative irradiation (two), postoperative prophylactic irradiation (34), radical irradiation (17), and recurrent case after operation or irradiation (eight). The survival rate in the various categories is examined. Some patients developed maxillary cancer with metastatic neck nodes, and 21 of these were treated for this condition (seven irradiation, 14 operation and irradiation). The results of the treatment are compared according to type and radiation source used also reviewing some side effects of irradiation. (TTT)

31862 SKELETAL ALTERATIONS IN THE CUSHING'S SYNDROME AND THEIR MODIFICATIONS CONSECUTIVELY TO THE INTRAPITUITARY IMPLANTATION OF ^{90}Y. Juliani, Giovanni; Ragni, Giorgio (Univ., Turin). J. Radiol., Electrol., Med. Nucl., 49: 909-16(Dec. 1968). (In French).

The 33 patients studied have exhibited skeletal alterations expected in Cushing's syndrome; however, an important frequency (22.6%) of pathologic fractures of the ischio-pubic branches was observed and ischemic necrosis of the femoral heads (3 cases out of the 31 submitted to roentgenograms of the pelvis) was found. Nine of these patients benefitted from an intrapituitary implantation of ^{90}Y and in 7 of these cases it has been possible to note the disappearance of the osteoporosis. Since these patients have been observed for three years, this is considered an effective treatment. Of course, it has not been possible to modify the femoral deformity conditioned by the isochemic necrosis in the cases in which it existed. (C.O.)

31863 STUDY OF THE POSSIBILITY AND UTILITY OF THE SOLE TELECOBALTOIRRADIATION IN THE PREOPERATIVE TREATMENT OF THE UTERINE CANCERS (ANATOMO-CLINICAL CONTRIBUTION). Laddaga, M.; Calderazzi, A.; Sargenti, A. (Univ., Pisa, Italy). Radiol. Med., 54: 666-89(July 1968). (In Italian).

In a series of 37 cases (18 tumors of the cervix and 19 tumors of the corpus of the uterus) a preoperatory telecobaltotherapy by means of a bipendular technique has been performed. On the basis of the results of the histological test of the operatory section, the present condition of the patients, and the complications observed the preference for sole outside supervoltage irradiation over other methods of treatment is explained. The effectiveness of this method on the principal vessels and lymph nodes, the possibility of complete histological sterilization of the primitive lesion (59 per cent of the presented cases) without supplementary endocavitary irradiation, and the advantage of distributing the dose suitably have been demonstrated in this small series of cases. It is believed that irradiation at large volume is better to reach a treatment dose not too high (4500 R) and to execute simple surgery to exploit the advantages of this form of radiosurgical association and to limit its complications. (C.O.)

31864 CURIE THERAPY WITH ^{192}Ir. Pierquin, B. (Institut G. Roussy, Villejuif, France); De Maio, G. Nunt. Radiol., 33: 1363-7(Nov. 1967). (In Italian).

Iridium-192 gave good results when used as a substitute for Ra for contact therapy of neoplasms of the mouth, nose, female genitalia, and skin. Techniques used are described and results are summarized for over 2200 cases. (C.H.)

31865 SENSITIVITY OF PLANTAR WARTS TO ROENTGEN RADIATION. Reymann, Flemming (Finsen Inst., Copenhagen). Acta Dermato-Venereol., 49: 171-5(1969).

A very high incidence of radiation injuries occurred after treatment of plantar warts with ultrasoft x rays and Ra. Among 70 patients who had been treated with 35-KV x rays for plantar warts 14 yr previously, receiving a single dose of 3000 R x-ray cicatrices in the form of atrophy or hyperkeratosis were found in 50 patients (71.4%), 10 of whom had subjective complaints (14.3%). Another group treated with Ra comprised 49 patients examined 20 yr after treatment. Radiation cicatrices were found in 31.7% after 1 Ra treatment, and in patients treated twice for the same plantar wart, 87.5%. It was thus considered inadvisable to treat plantar warts with x rays or Ra at doses as high as these. For that reason, attempts were made to assess the sensitivity of plantar warts to x radiation by conducting a clinical therapeutic trial to determine if lower doses could be used. An x-ray quality with an HVL (half value layer) of ~2 mm of skin was estimated as being most useful in these therapeutic experiments. Single doses of 200, 500, and 1000 R were tested. The results showed that the sensitivity of plantar warts to x radiation, within a dose range which should not give rise to late injuries, is so low that this type of therapy is unsuitable for routine treatment. (BBB)

31866 RESULTS OF COBALT TELE-IRRADIATION IN BLADDER NEOPLASMS. Hanschke, H. J.; Braun, J. S. (Univ., Homburg/Saar, Ger.). Z. Urol., 61: 381-91(June 1968). (In German).

Effects and complications of ^{60}Co irradiation on 35 patients treated for bladder carcinoma were reported. The advantage of the ^{60}Co irradiation was that it was more penetrating, because it was possible to attain 50% of the incident irradiation at a tissue depth of 10 cm, as compared to only from 25 to 30% of the incident dose of conventional x irradiation. This reduced proportionately the incidence of irradiation effects produced on other, non-target tissues. In addition, a more exact dose distribution was achieved with the ^{60}Co irradiation, because its absorption in soft tissues and bone was similar. The total tumor doses administered ranged from 5500 to 6000 R. In only three cases was it necessary to break off the ^{60}Co irradiation treatments because of poor tolerance. The ^{60}Co irradiation treatment was well tolerated by 24 patients, moderately well in 3 patients, and poorly by 8 patients. Most of the ^{60}Co irradiation side effects consisted of tenesmus or radiation cystitis. (BBB)

31867 MELANIN FORMATION AND DISAPPEARANCE IN URTICARIA PIGMENTOSA AFTER ETHYL CHLORIDE SPRAY AND AFTER X RAYS. Stuettgen, G. (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). Hautarzt, 19: 456-8(Oct. 1968). (In German).

Effects of x irradiation on skin of four patients with disseminated urticaria pigmentosa were studied. After dermopan irradiation doses of 400 R the pigmented areas disappeared. The metabolic relations between melanin formation and mast cell proliferation and the possible pathway of increased melanin formation were reviewed briefly. It was suggested that in urticaria pigmentosa biogenic amines from the granula of the mast cells may evoke wheal formation. After uv irradiation tyrosine oxidation and pigment formation could be initiated by mast cells. It was suggested that irradiation injury of mast cells might cause melanin disappearance, but that when the mast cells recovered from irradiation, as evidenced by formation of typical wheals, melanin formation was resumed. (BBB)

31868 CLINICAL RESULTS AFTER INTERSTITIAL IRRADIATION OF THE PITUITARY GLAND WITH ^{90}Sr. Notter, Gustaf; Melander, Olle; Dahlgren, Sven (Karolinska Sjukhuset, Stockholm, Karolinska Institutet, Stockholm). Strahlentherapie, 136: 643-9(Dec. 1968). (In German).

The results of an interstitial irradiation of the pituitary gland in 27 patients are reported. The radiation source was an applicator loaded with ^{90}Sr, 4.5 mm long. With a central and bilateral application, the dose was not sufficient to obtain in most of the cases a complete destruction of the pituitary. Since then the adeno- and neuro-hypophysis are irradiated separately. After a dose of 40 Krad at 4 mm depth a complete ablation was obtained in 10 cases of 13. The threshold dose to obtain necrosis of pituitary cells lies between 35 and 40 Krad. The complication rate was low. This method is actually preferred to yttrium-90 or gold-198 rods. The reasons are discussed. (auth)

31869 RADIATION THERAPY IN VETERINARY MEDICINE. Pennock, P. W. (Univ. of Guelph, Ontario). Can. Vet. J., 8: 169-72(Aug. 1967).

Some of the principles of radiation therapy are discussed. The importance of using a machine designed especially for therapy is emphasized. Histopathological examination of the tumor and radiographs of the thorax are important parts of the diagnostic procedure prior to therapy. The administration of oxygen during therapy, adequate coverage of the lesion, the importance of the quality of the x-ray beam and fractionation of the total dose are covered. Brief mention is made of radioactive isotopes and their use in therapy. (auth)(Canada)

31870 RADIOACTIVE COLLOIDAL CHROMIC PHOSPHATE IN THE TREATMENT OF OVARIAN MALIGNANCIES. Hester, Lawrence L. Jr.; White, Larry (Medical Coll. of South Carolina, Charleston). Amer. J. Obstet. Gynecol., 103: 911-18(Apr. 1, 1969).

An empirical study of determination of cancericidal doses of ^{32}P as chronic phosphate in the abdominal cavity and complications of treatment following use for the treatment of ovarian neoplasms was made in 33 patients. Advantages of ^{32}P in this form over ^{198}Au were also considered. Both isotopes when placed in a serous cavity are diffused throughout the fluid, and plate out on the serosal surfaces. Some are taken up by the reticuloendothelial cells and there cause mesothelial fibrosis, fibrosis of small blood vessels, and direct action on tumor seedlings or free tumor cells. Since ^{32}P is a pure β emitter, the irradiation hazard is reduced. It has a half-path penetration in tissue of about 0.4 mm and a maximum penetra-

tion of less than 4 mm. It has an average urinary tract excretion of 5% in 11 days and less than 1% of the dose is present in the blood at any one time. With ^{198}Au γ rays contribute 6 to 10% of the total dose. Thus ^{32}P is preferred for intracavitary use, since it is easier to handle, there is much less deterioration caused by a longer half-life, and the irradiation effect on the serosal surface and omentum is probably greater. The 33 patients with ovarian cancer received ^{32}P intra-abdominally, about 7 mCi being given first on the fourth to seventh postoperative days when the patient was eating a regular diet. This dose was repeated at weekly intervals. Most patients received 28 mCi of ^{32}P in four injections with a week between each injection. Although it appeared that the best results were obtained with 14 mCi of ^{32}P injected into the abdominal cavity, this was probably incorrect. Five patients received 14 mCi intraperitoneally and are all living. Three patients that received ^{32}P developed complications. Each resulted from pooling of the radioisotope or inadequate dilution of ^{32}P in normal saline. The patients developed abdominal distention, a burning sensation in the epigastrium, or severe abdominal discomfort. (BBB)

31871 EFFECT OF EXTRA-CORPOREAL IRRADIATION OF THE BLOOD ON BONE MARROW ACTIVITY IN ACUTE LEUKEMIA. Chan, B. W. B. (Cambridge Univ., Eng.); Hayhoe, F. G. J.; Bullimore, J. A. Nature (London), 221: 972-4(Mar. 8, 1969).

The use of extra-corporeal irradiation of the blood (ECI) in the treatment of acute leukemia has been based on the theoretical assumption that exchange of leukemic cells between blood and bone marrow may occur and that continued irradiation of the blood might eventually lead to the destruction of a large proportion of the total burden of leukemic cells. In a patient with acute myeloid leukemia treated by ECI, however, it was observed that on each occasion the blast cell count rose sharply after the treatment was stopped. Analysis of published records also showed a similar rebound effect. It thus seemed possible that destruction of cells by ECI might stimulate the marrow to increased proliferative activity, possibly through a feedback mechanism. The studies described were made with a view to testing this hypothesis. It was also thought that an intensive course of chemotherapy immediately following ECI might prove exceptionally effective. ECI was performed on two patients using a ^{90}Sr and ^{90}Y irradiator. Case 1, suffering from acute myelomonocytic leukemia received 22,000 R, and case 2, suffering from acute myeloblastic-promyelocytic leukemia, received 12,000 R to whole blood. Bone marrow samples were taken. Experimental details are given in full and results summarised in tabular form. In both cases the mitotic index was greatly increased after ECI, and samples showed greatly increased cellularity. Increases of the proportion of cells in S phase were shown by increase in percentage of ^{3}H-thymidine labeled cells. It was concluded that, in the two cases studied the proliferative activity of the leukemic cells in the marrow did not remain stable during ECI, but was considerably increased. The theoretical and practical implications of the results are discussed. From the point of view of practical therapy the findings suggest that ECI may be used to manipulate the cycle of the leukemic cell as part of an overall therapeutic strategy in conjunction with intensive chemotherapy at the stage of maximum proliferative response in the marrow. On the other hand, experience with patients with acute myeloid leukemia suggests that ECI is of restricted value by itself in this form of the disease, and without the support of chemotherapy the effect may be to increase the total leukemic cell mass. (UK)

31872 RECONSTRUCTION OF THE HYPOPHARYNX AND CERVICAL ESOPHAGUS: LOCAL FLAP TECHNIQUE AFTER PLANNED PREOPERATIVE IRRADIATION. Litton, W. B. (Univ. of Iowa, Iowa City). Trans. Amer. Acad. Ophthalmol. Oto-laryngol., 72: 85-9(Jan.-Feb. 1968).

Radiotherapy of epidermoid carcinomas involving the lower hypopharynx and upper esophagus (the so-called epiesophagus) may result in a high rate of skin injury. A simple surgical method of reconstruction of the hypopharynx and cervical esophagus is presented which may be used after preoperative radiation therapy. A tumor dose of 4000 to 4500 R was given employing ^{60}Co. A three-week period elapsed between the cessation of irradiation and the surgical treatment described. Three flaps of tissue are used to reconstruct the heavily irradiated skin and other structures. These flaps include the platysma muscle. A short full-thickness flap forms the posterior wall of the reconstructed alimentary passage. A longer full-thickness flap receives a split-thickness graft on its deep side. Above, this graft is sewn to the anterior wall of the hypopharyngeal inlet and below it is sewn to the anterior wall of the esophagus. A full-thickness flap is attached to the skin of the submentum above and the upper edge of the advanced thoracic flap below. The components of these flaps and grafts are illustrated. Successful use of this procedure in three cases is described. (BBB)

31873 RADIOGOLD SEED THERAPY FOR GYNECOLOGICAL TUMORS. Glaser, Felix Herbert (Martin-Luther-Univ., Halle-Wittenberg, Ger.). Strahlentherapie, 137: 277-82(Mar. 1969). (In German).

A method for permanent implantation of gold-seeds (^{198}Au) is described for treatment of gynecological tumors. This method has distinct advantages over radium needles. The principal indications are primary tumors of vulva and vagina, and recurrences after surgical or radiological treatment. (auth)

31874 A QUANTITATIVE ANALYSIS OF TREATMENT MODELS FOR DIFFERENT TYPES OF RADIATION. Wideroee, Rolf. Strahlentherapie, 137: 292-9(Mar. 1969). (In German).

The radiobiological effects of alpha as well as beta particles are the basis for a model for all ionizing radiations. Calculation of optimal irradiation programs, based on certain conditions, is studied. The most favorable dose per fraction for different kinds of radiations is investigated. The comparison shows that high-energy electron beams give the best results and that high-energy neutrons are only advantageous in cases where the possibility of reoxygenation of anoxic tumor cells exist. (H.B.G.)

31875 INCIDENCE OF SECOND CANCERS AFTER RADON SEED THERAPY FOR CERVIX CANCER. Graham, John; Burstein, Paul (Roswell Park Memorial Inst., Buffalo. State Univ. of New York, Buffalo). Acta Radiol., Ther., Phys., Biol., 7: 453-61(Dec. 1968).

Patients with carcinoma of the cervix first seen in the period 1927 to 1953 were studied. Radiotherapy including radon seeds was given to 2,069 patients and without seeds to 2,146 patients. All were followed up for periods between 10 and 35 years. Age, stage, distribution and survival rates in the two groups were about the same. The frequency of secondary cancer in the non-seed cases was twice that in the radon seed group. The difference is probably significant for it was found throughout the period of observation. The reason for the difference is not clear. (auth)

31876 LOCALIZATION METHODS AND TREATMENT PLANNING FOR IRRADIATION OF THE URINARY BLADDER WITH FAST ELECTRONS. Alth, Gerhart (Krankenhauses der Barmherzigen Schwestern, Linz, Austria). Strahlentherapie, 137: 283-7(Mar. 1969). (In German).

It is shown that irradiation of the urinary bladder with electrons is possible only after an exact preparation of treatment planning. With the aid of a localizer and a contour-apparatus functionally and mechanically coupled with the localization-table, a coordinate system can be established according to the patient's dimensions. This allows a precise determination of the tumor dose and accurate treatment planning. The necessity of individual localization and treatment planning is stressed and outlined. (auth)

31877 CRITERIA FOR FRACTIONATED RADIOIODINE THERAPY OF HYPERTHYROIDISM. Reinwein, D.; Klein, E.; Horster, F. A.; Gabe, D. (Univ., Duesseldorf). Verh. Deut. Ges. Inn. Med., 73: 372-5(1967). (In German).

Dose considerations, results, and complications of fractionated ^{131}I treatment for hyperthyroidism in patients without endocrine eye symptoms or toxic adenomas were reported. Using an initial ^{131}I dose of 1.5 to 6.5 mCi of ^{131}I the incidence of subsequent hypothyroidism observed in 356 patients was less than 1%. The second dose of ^{131}I ranged from 3 to 10 mCi of ^{131}I, and, when a third dose of of ^{131}I was required, it averaged 7.6 mCi. The average general concentration of ^{131}I in the thyroid gland was not less than the dose used for radioresection by a single administration of ^{131}I. The factors that were found to be most important to reach the total concentration of ^{131}I needed to produce euthyroidism and avoid hypothyroidism were size of the gland, effective ^{131}I half time, degree of goiter, and age of the patient. (BBB)

31878 BIOLOGICAL EFFECTS OF FAST ELECTRONS IN DIFFERENT TISSUE DEPTHS. Maurer, Hans-Joachim; Heinzler, Franz (Univ., Duesseldorf). Strahlentherapie, 137: 288-91(Mar. 1969). (In German).

Studies concerning the efficiency of 30 MeV electrons at different depths on the roots of Vicia faba and on riboflavin (Vit. B_2) are reported. In both systems, the efficiency was the highest at the maximum dose levels (100% isodose at 3.5 cm depth). At the 50% level (11.5 cm depth) the efficiency was less. These results show that there is no enhancement of the relative biological efficiency with depth. The increase of delta-electrons plays no particular role in the radiotherapeutic range of depth. (auth)

31879 DIAGNOSIS AND THERAPY OF MALIGNANT BONE TUMORS AND SARCOMAS OF SOFT TISSUES: THERAPY DATA FOR THE YEARS 1960 TO 1965. Hoppe, Dietrich (Humboldt-Univ., Berlin). Strahlentherapie, 137: 253-63(Mar. 1969). (In German).

Bone sarcomas in adults and children observed between 1960

and 1965 were treated with a combined method of surgery and radiotherapy. Telecobalt or high-energy x rays are recommended, combined with supplementary chemotherapy. The five year survival for adults with osteosarcomas is approximately 20%. The results in children and adolescents are much better. Most of the 74 soft tissue sarcomas were followed by metastases during the first year after treatment and their prognosis was poor. (H.B.G.)

31880 COMBINATION THERAPY OF TUMORS OF THE LIP, TONGUE, AND LARYNX WITH FAST ELECTRONS (6 TO 17.5 MeV). Van Vaerenbergh, P. Maurits; Schelstraete, Karel; Simons, Maria (Univ., Ghent). Strahlentherapie, 137: 264-6 (Mar. 1969). (In German).

The application of fast electrons from a betatron combined with surgery and other radiological methods for tumors of the lips, the tongue, and the larynx is reported. Isodoses are shown and the best moment of the electron treatment is discussed. (auth)

31881 SOME MODERN RADIUM APPLICATORS AND TREATMENT POLICIES FOR CANCER OF THE CERVIX. Truskett, Ian D.; Batley, Frank; Constable, William C. (Upstate Medical Center, Syracuse, N. Y.). Med. J. Aust., 2: 139-45 (July 22, 1967).

Dosimetry, radiobiologic implications, and prevention of local radiation injury in the use of Ra applicators are reviewed. Types of afterloading applicators in use for the treatment of carcinoma of the cervix are described. These have some technical advantages and some disadvantages. Their use reduces the radiation exposure to operators and nursing staff. Relative advantages of Ra and ^{137}Cs are compared. The difference in energy of the γ rays from radiocesium compared with those from Ra is not of clinical importance. The β particles emitted in decay from ^{137}Cs to ^{137}Ba are mostly of 500 keV and are completely absorbed by the 0.5 mm platinum tube wall. With Ra some of the more energetic β particles escape. (BBB)

31882 PROBLEMS IN RADIOIODINE THERAPY OF THYROID TUMOR. von zur Muehlen, A.; Emrich, D. (Univ., Goettingen, Ger.). Verh. Deut. Ges. Inn. Med., 73: 375-9 (1967). (In German).

Optimum conditions for radiation treatment of thyroid tumors were discussed. Treatment with ^{131}I caused alterations of the tumor to an anaplastic structure with the result that tumor growth became independent of the ^{131}I administration. In the mixed tumors the portions that incorporated the ^{131}I were destroyed, leaving the tumor portions that did not incorporate ^{131}I. This resulted in dedifferentiation and worsening of ^{131}I treatment prognosis. Treatment with ^{131}I was limited because of the restriction of whole-body irradiation to a total of 400 rad/dose of ^{131}I. In the dose range of 100 to 150 mCi of ^{131}I there were no side effects observed, such as development of a radiation syndrome or localized inflammation. Dosage was carefully controlled in patients with diffuse lung, brain, or bone metastases. The most severe complication from ^{131}I treatment was fatal cerebral edema observed in a patient with a single intracerebral metastasis. (BBB)

Blast and Thermal Effects

Refer also to abstract 31726.

31883 EFFECTS OF NUCLEAR WEAPON DETONATIONS ON THE HUMAN ORGANISM AND MEASURES OF MEDICAL ASSISTANCE. Koenig, W. Deut. Stomatol., 17: 292-301 (Apr. 1967). (In German).

Characteristics of atomic weapons detonations that may affect human populations are itemized and discussed. The energy released by atomic detonation includes 30 to 40% light radiation and about 20% ionizing radiation. External whole-body irradiation, irradiation of body areas, and organ systems, internal contamination of nose and throat, lungs, gastrointestinal tract, and incorporation of radioactive fallout materials are itemized. Radiosensitivities of various organs are listed, and effects of single doses of whole-body irradiation ranging up to 800 R are tabulated. Procedures for the treatment of survivors irradiated with dose ranges of 100 to 300, 300 to 750, and more than 750 R are described briefly. Probable incidences of irradiation injuries are listed. Possible preplanned measures of radiation protection, effects on survival after irradiation, including immediate protective steps, limitation of exposure times, use of shelters and buildings, protective clothing, first aid, and general sanitation are mentioned briefly. (BBB)

Radiation Effects on Animals

Refer also to abstracts 31649, 31658, 31674, 31715, and 31819.

31884 QUANTITATIVE STUDIES OF IN VITRO TRANSFORMATION BY CHEMICAL CARCINOGENS. DiPaolo, J. A.; Donovan, P.; Nelson, R. (National Cancer Inst., Bethesda, Md.). J. Nat. Cancer Inst., 42: 867-74 (May 1969).

The addition of carcinogenic polycyclic hydrocarbons to cells of Syrian hamster embryos resulted in the formation of altered clones not seen with control conditions. The presence of altered clones was not due to the x-irradiated feeder cells or the antibiotics. The addition of carcinogens produced a crisscross pattern of both light and dense clones. Altered clones were obtained with both random-bred and inbred hamsters. The frequency of appearance of altered clones was related to the known carcinogenic potency of the compounds tested. Toxicity increased with the amount of the compound and was related to its potency as a carcinogen. At constant carcinogen concentration the number of altered clones increased with the number of cells exposed. Positive results were obtained with carcinogen concentrations yielding about a 50% decrease in cloning efficiency, which suggests that the alteration was due to induction rather than to selection. (auth)

31885 CERTAIN ASPECTS OF THE MORPHOGENESIS OF THE HETEROPLOID CELLS FROM ABNORMAL MITOSIS CAUSED BY X RAYS. Carosi, G.; Gerna, G.; Santagati, G.; Cerra, E. (Univ., Pavia, Italy). Arch. Sci. Med., 124: 592-9 (Dec. 1967). (In Italian).

Cultured erythroblast cells from newts (Molge vulgaris) were exposed to 25 R x radiation, and the mitotic cycle was observed microscopically during the next 24 to 36 hr. Photomicrographs recorded abnormal mitotic patterns; effects of radioinduced changes during mitosis on the morphology of mature erythrocytes were also studied. (C.H.)

Invertebrates

Refer also to abstracts 31709–31714, and 31717.

31886 (COO-1429-5) STUDY OF RADIATION ON THE BIOLOGY AND POPULATION DYNAMICS OF THE CEREAL LEAF BEETLE, OULEMA MELANOPA (L). Final Report, September 1, 1968–January 31, 1969. Myser, Willard C. (Ohio State Univ. Research Foundation, Columbus). Apr. 21, 1969. Contract AT(11-1)-1429. 29p. Dep. CFSTI.

Larvae of the wax moth (Galleria melonella) were used for hemocyte studies. The larvae were x-irradiated and electron micrographs of hemocytes removed from the larvae 24 hrs post-irradiation showed extensive damage. The hemocytes were swollen and the endoplasmic reticulum, golgi apparatus, and nuclear membrane had disintegrated. Mitochondria were in various stages of disintegration. The cytoplasm contained large vacuoles with cellular debris. The effects of radiation on the free amino acid concentration of the hemolymph of the honeybee (Apis mellifera) were studied. It was found that there was a trend toward an increase in free amino acids in hemolymph from irradiated prepupae. Studies on population regulating mechanisms in the cereal leaf beetle (Oulema melanopa) were conducted using the sterile male technique. Results indicated that x radiation of males might significantly reduce the hatchability of eggs laid by females previously mated with them. (H.L.W.)

31887 SENSITIVITY DIFFERENCES IN THE SUCCESSIVE STAGES OF SPERMATOGENESIS IN DROSOPHILA AFTER IRRADIATION IN NITROGEN OR AIR. Shiomi, Toshio (Nuclear Energy Research Centre, Karlsruhe, Ger.). Mutat. Res., 4: 323-32 (May-June 1967). (KFK-583).

Male fruit flies were exposed to radiation doses between 1000 and 4000 R in either air or nitrogen. Exposure in nitrogen leads to a reduction in the mutation and translocation frequencies, especially in broods produced several days postexposure. The results indicate that the oxygen level during radiation affects differently mature and almost mature spermatozoa. (H.B.G.)

31888 STUDIES ON ALPHA RADIATION SENSITIVITY OF EMBRYONIC STAGES OF DROSOPHILA MELANOGASTER. Schneider, Eckart; Schraub, Alfred; Sattler, Ernst-Ludwig; Waldvogel, Horst (Univ., Giessen, Ger.). Strahlentherapie, 137: 119-21 (Jan. 1969). (In German).

The α-radiosensitivity of embryonal stadia of Drosophila melanogaster (Berlin-wild) was examined between 0 and $4\frac{1}{2}$ hrs after laying, keeping the age variation as small as possible. An ^{241}Am plate was the source of alpha rays. The effect of x rays was also studied for comparison. By determining the LD_{50} for alpha and x rays, a RBE of about one was obtained, when the rate of eclosion was considered. (auth)

31889 DIFFERENCES BETWEEN RADIATION-INDUCED LIFE SHORTENING AND NATURAL AGING IN DROSOPHILA MELANOGASTER. Atlan, Henri; Miquel, Jaime; Binnard, Rosemarie (Ames Research Center, Moffett Field, Calif.). J. Gerontol., 24: 1-4 (Jan. 1969).

An investigation of mortality kinetics supported the view that

essential differences exist between radiation-induced life shortening and natural aging in Drosophila. Oregon R wild type males were used to determine the mean survival times under normal conditions and following irradiation with 50 KR of ^{60}Co γ rays. For flies 1 to 20 days old at irradiation the mean survival time after exposure was constant and equal to 30 to 31 days. Flies irradiated at older ages had a decreasing surviving time after irradiation. These two patterns could be related to the parts of the mortality curves for control flies. If irradiation and death occurred during the plateau phase (up to ~50 days), a displacement in the time of irradiation resulted in an equal displacement in the time of death. This suggests that radiation-induced life shortening is a specific radiation syndrome that needs a constant period of time to induce death. This pattern holds until 20 days of age at the time of irradiation, which corresponds to 50 days of age at death. Only later, when postirradiation death occurs in the dying phase of the control groups, are the natural causes of death additive with radiation injury in shortening survival time. (BBB)

31890 RADIOSENSITIVITY OF DROSOPHILA SPERMATOGONIA. IV. MUTATION INDUCTION IN SYNCHRONOUS EMBRYOS. Oftedal, P. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 97-106(1968).

The reported experiments demonstrated variation in sensitivity to mutation induction by radiation in synchronously developing embryos of D. melanogaster. Male flies were mated at various times after being exposed to 140- or 279-rad doses of x rays and sex-linked lethal frequencies were determined in late stage embryos. Altogether nine irradiation series were studied, comprising a total of 92,549 chromosomes tested and yielding 476 lethals. In control series, a total of 47 lethals was found in 11,376 chromosomes tested (0.41%). All lethals except two were found singly in the offspring of different females. In irradiated groups the observed mutation frequency varied between age groups in a highly irregular manner after both 140 and 279 rad. No clear indication of a common pattern between the two mutation-age curves was seen, except possibly a tendency towards higher values in the middle of the ages covered (a tendency also present in the control series). The mutation frequency curve after irradiation with 140 rad showed three sharp peaks at the ages of 1801 to 1830 hr, 1946 to 2000 hr, and 2131 to 2145 hr. These peaks reached a level of 0.5 to 0.6% lethals, while the troughs between them, on the other hand, were from 0 to 0.2% above control level. The curve indicates a real variation in genetic radiosensitivity with age. Thus, cyclic variation with age at exposure in mutation frequency above controls was found, indicating variation in genetic radiation sensitivity during the mitotic cycle of approximately synchronously dividing spermatogonia. (BBB)

31891 BIOLOGICAL PROPERTIES AND CHARACTERISTICS OF BABESIA BIGEMINA. IONIZING RADIATION EFFECTS ON INFECTIVITY OF INFECTED WHOLE BLOOD. Castro, Edin Raul; Canabez, Freddie (Univ., Montevideo). Bol. Chil. Parasitol., 23: 30-3(Jan.-June 1968). (In Spanish).

Studies were conducted on the effects of ^{60}Co radiation on the infectivity of whole blood infected with Babesia bigemina in 13 splenectomized and 13 normal cattle. Blood infected with B. bigemina was irradiated with 1000- to 100,000-R doses and inoculated intradermally or subcutaneously into the 26 cattle. Hematologic parameters and incidence of infection were followed. All of the animals receiving nonirradiated infected blood became infected, as did those receiving blood irradiated with doses below 30,000 R (25,000 R or less). No infections occurred in normal or splenectomized animals inoculated with 30,000-, 35,000-, 40,000-, 45,000-, 50,000-, or 100,000-R irradiated samples. It was concluded that dose levels of 25,000 R or less did not destroy the disease-producing capacity of the parasite, but 30,000 and 100,000 R prevented the onset of the disease. (BBB)

31892 A MODEL FOR ULTRAVIOLET AND PHOTOREACTIVATING LIGHT EFFECTS IN EUGLENA. Hill, Helene Z. (Univ. of Colorado, Denver); Alling, David W. Biophys. J., 9: 347-59(Mar. 1969).

Euglena gracilis is particularly suitable for the study of uv radiation effects since its chloroplast-forming system is considerably more sensitive to uv than is its colony-forming ability. Furthermore, uv damage to the chloroplast-forming system is completely reversible by photoreactivating (PR) light over a wide range of doses. A unified model is described which furnishes predictions about both uv and PR effects in Euglena. The model predictions are compared with data presented earlier. Target theory was assumed to apply to the uv inactivation of chloroplast formation. A germicidal lamp was used as a uv radiation source (90% of the output at 2537 Å) and a black light as a PR source (peak output at 3500 Å). The model consists of the following postulates: A Euglena cell contains n centers, each of which is composed of m sites. Sites interact with uv and PR radiation; individual sites interact independently of one another. If a site has interacted with a uv photon, and thereby undergone a photochemical change, it is said to be occupied. Interaction of an occupied site with a photon of PR renders it unoccupied, i.e., subject to interaction with a photon of uv. Occupied sites will not interact with uv, nor will unoccupied sites interact with PR. The chance that an occupied site will interact with a photon of PR (i.e., the cross-section for photoreactivation) decreases hyperbolically as the dose of the antecedent uv increases. The chance that an occupied site will interact with PR decreases exponentially with the duration of incubation in nutrient medium. In order for a cell to form a green colony it must have at least 1 center free of occupied sites. A center with 1 or more occupied sites will not replicate; during mitosis centers are randomly distributed among daughter cells. Decay of photoreactivability is unaffected by mitosis. Reasonably good agreement was found in applying the model postulates to experimental situations. (BBB)

31893 EFFECTS OF GAMMA RADIATION ON TEMPERATURE, HUMIDITY, AND RESPIRATION RESPONSES IN THE HOUSEFLY, MUSCA DOMESTICA L. Glover, Sandra Jean. Athens, Ga., Univ. of Georgia, 1968. 56p.

Thesis.

Studies were carried out to determine if gamma irradiation of five day old pupae would alter the response of the adult houseflies (Musca domestica L.) to temperature and humidity gradients and to oxygen uptake. Pupae were radiated at three levels—2,000 R, 4,500 R, and 7,000 R—one above and one below the 100% sterilization dose of 4,500 R. Temperature and relative humidity preferences were tested separately in continuous gradient chambers. Oxygen requirements were determined using a Gilson Warburg apparatus. Flies were tested for temperature preference at 2, 5, and 9 days of age. Humidity preference was tested using 3, 6, and 10 day old flies. Oxygen requirements were determined for 1, 5, and 9 day old flies. In all tests, non-irradiated flies were used as controls. Data were analyzed by an analysis of variance. Analysis of data on the number of flies found at the various temperatures showed that older females (9 days) preferred a higher temperature (27.9°C) than younger flies (26.6°C). Non-irradiated females preferred a lower mean temperature (26.1°C) than irradiated females (26.9–27.1°C), but the level of irradiation had essentially no effect on temperature preference. Flies irradiated at the two higher levels showed a greater distribution (standard deviation) around the mean temperature than the non-irradiated or females irradiated at 2,000 R. No significant difference was found in temperature responses between irradiated and non-irradiated male flies. In tests for relative humidity preferences, 6 day old female flies showed a greater clustering tendency within the testing chamber than younger or older flies. There was no difference in the mean relative humidity preferred due to radiation effects. Ten day old males preferred a significantly higher ($P < .01$) relative humidity (75.7%) than 3 (73.0%) or 6 (73.7%) day old males. Males irradiated at the highest level had a relative humidity preference (75.3%) closer to the non-irradiated males (74.6%) than to either the 2,000 or 4,500 R radiation levels (72.8% and 73.9%, respectively). Oxygen requirements for both male and female flies were more markedly affected by age than by radiation. The oldest flies (10 day) had a greater requirement than the youngest flies. Irradiated males and females had a significantly greater ($P < .05$) oxygen requirement than non-irradiated flies. The oxygen requirement of females irradiated at 7,000 R was closer to the requirements of the non-irradiated than to the females of either of the other two irradiated groups. The females at these two lower radiation levels had the highest oxygen requirement. This was interpreted as due to egg maturation and radiation damage repair since eggs were produced by females at these two levels (2,000 and 4,500) but not by flies subjected to 7,000 R. (Disser. Abstr.)

31894 A STUDY OF THE CAUSES UNDERLYING THE DIFFERENCES IN RADIOSENSITIVITY BETWEEN MATURE SPERMATOZOA AND LATE SPERMATIDS IN DROSOPHILA. Sobels, F. H. (Univ. of Leiden). Mutat. Res., 8: 111-25 (July-Aug. 1969).

The basis for the differences in radiosensitivity between mature spermatozoa and late spermatids was analyzed by determining recessive lethal and translocation frequencies following irradiation in O_2, N_2, and air. Spermatozoa were sampled from the first ejaculate of 7-day-old males and spermatids from that of 1-hr-old males. The results indicate that the higher sensitivity of spermatozoa than of late spermatids after irradiation in air originates from a higher degree of oxygenation in the former than in the latter cells. Spermatozoa are not characterized by a greater sensitivity to irradiation in the presence of O_2 because the same oxygen enhancement ratios were recorded for both types of cells. These findings indicate that in late spermatids, a mechanism other than the one

postulated to explain differential sensitivity of the early ›rma-tids (which are characterized by an oxygen enhancemen' .atio of 3.3 and thus by greater radiosensitivity in O_2 than spermatozoa) operates. The somewhat greater sensitivity to irradiation in air of spermatozoa in the male than in the inseminated female is also ascribed to a higher degree of oxygenation, because equal yields of recessive lethals were obtained after irradiation in both O_2 or N_2. After radiation exposure in O_2 higher translocation yields were obtained from spermatozoa in females than in males. Since the lethal data suggest that the level of genetic radiation damage induced is approximately the same in both kinds of sperm, it is inferred that the conditions for repair of lesions leading to aberrations are less favorable when sperm is exposed to irradiation in O_2 in females than in males. In confirmation of an earlier report by Falk, mating of irradiated males to females with an attached X·Y-chromosome resulted in an increased recovery of II-III translocations. (auth)

Vertebrates

Refer also to abstracts 31602, 31603, 31635, 31639–31642, 31644, 31645, 31653–31655, 31657, 31659, 31661, 31665, 31666, 31668, 31671–31673, 31675, 31684, 31692, 31716, 31818, 31819, and 31821–31827.

31895 (AD-464449) EFFECTS OF TOTAL-BODY X-IRRADIATION ON PERITONEAL CELLS OF MICE. Kernfeld, Lottie; Greenman, Vivian (Naval Radiological Defense Lab., San Francisco, Calif.). May 28, 1965. 26p. (USNRDL-TR-841; NAVMED-MR-005.08-5200-2). CFSTI.

Peritoneal cells of normal and irradiated LAF1 mice which had not been pretreated with peritoneal irritants were studied by phase-contrast microscopy and in stained smears. The average number of leucocytes recovered per normal mouse were 7.4 million. Approximately 95% of the cells were mononuclear; of these, macrophages comprises 29% (2.2 million), small and medium lymphocytes 71% (as determined by phase-contrast). One day after whole-body exposure to 690 R (LD30/30) or 720 R (LD50/30) the mean leucocyte count was 3.4 million macrophages accounted for 65% (2.2 million) of the cells. From 3 to 21 days postirradiation, cell counts gradually decreased further to 1.5 million. Macrophages decreased at the same rate; they constituted approximately 79% of the cells during this period. Thereafter, the number of leucocytes increased and reached normal levels by the 12th week postirradiation. When suspensions of viable Escherichia coli or Staphylococcus aureus were injected 30 minutes before sacrifice, the macrophages of both normal and irradiated mice contained large numbers of microorganisms. Thirty minutes after injection of bacteria or E. coli lipopolysacchride (10 micrograms) into normal mice, the number of cells in peritoneal washings was not altered. However, after injection of these agents into irradiated mice, total cell counts were significantly lower than in uninjected or diluent-injected mice. (auth) (USGRDR)

31896 (AD-679698) VISUAL DISCRIMINATION PERFORMANCE IN THE MONKEY (MACACA MULATTA): A TECHNIQUE AND ASSESSMENT OF 5000 RADS GAMMA-NEUTRON IRRADIATION. de Haan, H. J.; Germas, J. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). June 1968. 33p. (AFRRI-SR-68-16). CFSTI.

A study was undertaken to assess the effects of radiation on visual discrimination performance in the monkey (Macaca mulatta). Six monkeys were trained to avoid shock by responding to one of two visual stimuli presented simultaneously. Each monkey was irradiated with approximately 5000 rads of gamma-neutron radiation delivered in a millisecond-range pulse. Behavioral data were obtained from ½ hour prior to the pulse and for 2-½ hours afterwards (Phase 1). Thereafter, behavioral data were obtained every 4 hours from pulse time (Phase 2). Temporary decrements in visual discrimination performance occurred in five out of six monkeys after exposure (median interval = 2 minutes, 10 seconds). The duration of the decrement varied between 7-½ minutes and 2-½ hours (the duration of Phase 1). All monkeys were able to perform visual discriminations at some time after irradiation. Maximum postirradiation performance during Phase 2 sessions occurred on the average at 8 hours postpulse, but ranged from 4 to 20 hours. Survival time varied from approximately 12-½ hours to 51-½ hours. Vomiting occurred in five out of six animals, but did not appear to interfere with effective performance. The results demonstrated a marked variability in the monkeys' response to radiation in both performance and survival time. (auth) (USGRDR)

31897 (AD-681465) EARLY EFFECTS OF 150-MeV PROTON IRRADIATION IN RHESUS MONKEYS. Report for July–November 1967. Traynor, Joseph E.; Siegal, Alan M. (School of Aerospace Medicine, Brooks AFB, Tex.). Sept. 1968. 15p. (SAM-TR-68-87). CFSTI.

Rhesus monkeys were exposed to 150-MeV proton irradiation at 11 rads per minute. After exposure, the animals were observed for clinical changes and mortality. Hematologic studies were performed up to 80 days after exposure. On the basis of acute median lethal dose, mean survival time, clinical observations and blood cell depression, an RBE of unity was assigned when comparing the 150-MeV proton exposures with 2-MeV x-ray exposures. A decrease in median lethal dose was noted with lowered dose rate when proton exposures at 57 rads per minute and 11 rads per minute were compared. (auth) (USGRDR)

31898 (AD-682199) MODIFICATION OF URETHAN-LUNG TUMOR INCIDENCE BY LOW X-RADIATION DOSES, CORTISONE, AND TRANSFUSION OF ISOGENIC LYMPHOCYTES. Cole, Leonard J.; Foley, William A. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 30, 1968. 23p. (USNRDL-TR-69-1). CFSTI.

Young adult male LAF1 mice were exposed to a single (300 R) dose of x rays, followed one day later by an intraperitoneal injection of urethan, 0.08 mg or 0.2 per gram body weight Cortisone acetate was injected subcutaneously, 7 injections of 2.5 mg each, on alternate days beginning one day after irradiation. The mice were sacrificed 25 to 26 weeks after urethan injection, and the enumeration of lung tumor incidence was made by standard procedures. The percent of mice bearing lung tumors was highest (50%) in the group receiving 300 R plus urethan (0.108 mg/g), as compared with 12.5% in the control mice irradiated only, and 16% in those receiving urethan only. Thus, x radiation and urethan can be additive for lung tumorigenesis. (auth) (USGRDR)

31899 (AD-682210) BONE MARROW CELLULARITY IN POSTIRRADIATED RATS. Rene, A. A.; Darden, J. H.; Baum, S. J. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1968. 32p. (AFRRI-SR-68-8). CFSTI.

The specific objectives of this study were to determine to what extent cell turnover (reproduction) effects the difference in radiation sensitivity of the individual cell types, and to investigate the relationship which exists among the cell types during the damage and recovery period. Six hundred and seventy-two rats were exposed to either of the two radiation sources and sacrificed at periodic intervals following exposure for the purpose of determining the change in numbers of cells in the marrow. The results indicate that the difference in the response of the individual types of cells is not directly related to their turnover rate. The turnover rate for the myelocytic cells is greater than the turnover rate for the erythrocytic cells, yet the erythrocytic precursor cells are more sensitive to radiation than the myelocytic precursor cells. The results also show that erythrocytic cells recover before myelocytic or lymphocytic cells. This recovery indicates that lymphocytic cells probably could not give rise to the other two cell types (function as a stem cell) through a process of differentiation or dedifferentiation. However, it may be possible that the lymphocytic cells could function as trephocytes. (auth) (USGRDR)

31900 (AD-682285) STRESS RESPONSE AS A PREDICTOR OF RADIOSENSITIVITY IN PRIMATES. Hamilton, Horace E.; Melville, George S. Jr. (School of Aerospace Medicine, Brooks AFB, Tex.). Nov. 1968. 12p. (SAM-TR-68-122). CFSTI.

Macaca mulatta primates were standardized and then subjected to stress in the form of prolonged breathing of an air atmosphere saturated with ethanol vapor. Significant changes ($P < .01$) were noted in their urine volumes and the excretion of electrolytes and 17-hydroxycorticoids. The primates were then irradiated with a lethal dose (1,100 R) of gamma radiation. Their survival times were recorded and tested for correlation with body weights, urine volumes, excretion of electrolytes and corticoids, and post-stress blood alcohol levels. The changes in the Na/K urinary ratio were found to be significantly ($P < .01$) related to the respective post-irradiation survival times, but no significant correlation between survival time and the other measuremenis was detected. (auth) (USGRDR)

31901 (AD-682288) DOSE RATE EFFECT OF LD50/30 IN MICE EXPOSED TO ^{60}Co GAMMA IRRADIATION. Traynor, Joseph E.; Still, Edwin T. (School of Aerospace Medicine, Brooks AFB, Tex.). Oct. 1968. 12p. (SAM-TR-68-97). CFSTI.

LD50/30 determinations were made on Swiss Webster female mice exposed to cobalt-60 gamma irradiation at five dose rates between 2.25 and 200 rads per minute. The results are analyzed by the Bateman formula, which makes a very accurate estimation of the LD50/30 in mice in the dose rate range studied. Preliminary data are presented which indicate that this formula will apply to dose rates as low as 100 rads per day. (auth) (USGRDR)

31902 (AD-683974) GENERAL PROBLEMS CONCERNING THE RADIO SENSITIVITY OF AN ORGANISM. Gorizontov, P. D.; Darenskaya, N. G.; Domshiak, M. P.; Tsypin, A. B. Translation of a Monograph. 40p. (FTD-MT-24-221-67). CFSTI.

An investigation was made of the overall sensitivity of living organisms of radiation. The following topics are discussed: variations in sensitivity to radiation in different species, variations in sensitivity to radiation in different strains of the same species, age-related differences in sensitivity to radiation, sex-related differences in sensitivity to radiation, seasonal variations in sensitivity to radiation, and variations in individuals of the same species in sensitivity to radiation. (auth) (USGRDR)

31903 (CEA-R-3693) EFFECT OF A NONLETHAL WHOLE-BODY GAMMA IRRADIATION ON THE SPONTANEOUS AND EVOKED ELECTROENCEPHALOGRAPHIC ACTIVITIES OF THE ADULT RABBIT. Court, Louis (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1969. 214p. (In French). Dep.

The whole of the experimental methods described (animal preparation, achievement of a precise physiological technique, dosimetry, biological information processing) allowed the changes in the spontaneous and evoked electroencephalographic activities to be followed for 15 days in rabbits submitted to a nonlethal 400 Rad whole-body γ irradiation. Behavioral troubles, changes in the arousal state, and the spontaneous electrical activity of the neocortex and hippocampus were observed continually; an enhanced cortical excitability, and the appearance of elements of the paroxystic series were noted with a general decrease in amplitude. After a visual stimulus the general morphology of evoked activities at the level of the primary visual areas and hippocampus was unchanged, but enhanced latencies and delays and less systematic modifications in amplitudes seemed to show a direct effect of radiation on the nervous system and sensorial activities; these effects seemed to occur independently of the basic electrical activity. As a whole, the changes observed were usually transitory and varied with each individual. An assumption is made to explain the mechanism of arousal troubles and the general evolution of spontaneous electrical activity in the brain. (auth)

31904 (CEA-R-3797) RADIOSENSITIVITY OF THE SWISS-RAP MOUSE AS A FUNCTION OF ITS GROWTH RATE. Legeay, Gerard; Glas, Jean-Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr. 1969. 16p. (In French). Dep.

The results are reported from an exhaustive study of the age-dependence of the γ-radiosensitivity of female SWISS-RAP mice. A close relation between radiosensitivity and age could not be demonstrated, whereas the weekly growth rate could be accurately related to radiosensitivity. Thus, the latter should be studied when this strain is to be used for biological experiments. The rates of growth differ with the strain of mice. (auth)

31905 (EUR-4097) PATHOGENESIS OF GENETIC AND SOMATIC RADIATION DAMAGE. Annual Report, 1966. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). 24p. (In German). Dep.

Results are reported from experimental studies on the frequency and mode of origin of genetic damage and delayed somatic damage induced in animals by ionizing radiation. Mutations at specific loci and lethal mutations were studied in x-irradiated mice and fish, and the effects of radiation on polygenic factors and the extent to which these are dependent on dose and dose-rate were measured. Functional disturbances of the nervous system after irradiation were studied in irradiated cats and the reaction potentials of various cortical regions were analyzed, and measurements concerning the electrical excitability of the neocortex were effected. Radiotoxicity studies included investigations of ^{224}Ra (thorium X) and comparison with the long-lived ^{226}Ra, with particular reference to the formation of bone tumors. A study was begun on delayed damage after the incorporation of ^{224}Ra in mice. Histopathological and histochemical studies were conducted on bones following internal and external irradiation, together with studies on the behavior of the alkaline phosphatase in the mucous membrane of the small intestine in mice after x irradiation, and on the influence of whole-body irradiation on the spleen enzyme pattern in various species of animals. (auth)

31906 (LF-39, pp 1-13) TOXICITY OF INHALED $^{90}SrCl_2$ IN BEAGLE DOGS. II. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Studies on the metabolism, dosimetry, and effects of inhaled $^{90}SrCl_2$ in the Beagle dog are continuing in an effort to provide a basis for assessing the consequences of inhaling ^{90}Sr such as might be released in certain nuclear accidents. Seventy-two dogs have been exposed to aerosols containing ^{90}Sr, resulting in initial body burdens ranging from 2.6 to 280 μCi ^{90}Sr/kg. Forty-eight of these dogs are being maintained for lifetime observation and have been placed in a longevity study consisting of four groups based on their retained ^{90}Sr burden at 14 days post-inhalation. Group means were 1.4, 6.2, 30 and 75 μCi ^{90}Sr/kg. Twenty-four dogs with a 14-day retained ^{90}Sr burden of 31 μCi/kg have been assigned to a sacrifice study. To date, eleven dogs have died or were euthanized; six during the first 31 days after inhalation with severe hematologic dyscrasia, one at 585 days with leukemia, one at 1099 days with an osteochondrosarcoma and three at about 1000 days after ^{90}Sr inhalation with angiosarcoma. Serial observations are continuing on all surviving dogs. (auth)

31907 (LF-39, pp 14-25) TOXICITY OF INHALED $^{144}CeCl_3$ IN BEAGLE DOGS. II. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Studies on the metabolism, dosimetry, and effects of inhaled $^{144}CeCl_3$ in the Beagle dog are continuing in an effort to provide information that will aid in assessing the biological consequences of inhaling ^{144}Ce such as might be released in certain nuclear accidents. Eighty-two dogs have been exposed to aerosols containing $^{144}CeCl_3$, resulting in initial ^{144}Ce burdens ranging from 2 to 700 μCi/kg. Twenty-seven dogs exposed so as to yield low body burdens have been observed by whole-body counting, periodic collection of excreta, and serial sacrifice at 2 to 512 days post-inhalation to aid in evaluating the metabolism and dosimetry of inhaled $^{144}CeCl_3$. Initially, the highest concentrations of ^{144}Ce were in lung; later the material was translocated to liver and skeleton. The highest cumulative radiation dose was received by liver, followed by lung and skeleton. Fifty-five dogs with initial ^{144}Ce burdens from 2.7 to 700 μCi/kg and 15 control dogs have been placed in a longevity study and will be followed for their lifespan. These dogs have been placed in five groups based on initial ^{144}Ce burden (group means 14, 51, 130, 280, and 480 μCi/kg). These were regrouped on the basis of retained ^{144}Ce at 14 days post-inhalation to yield groups with mean ^{144}Ce content of 5.2, 14, 40, 120, and 230 μCi/kg. Thirteen dogs from the two highest groups have died; eight at 21 to 44 days post-inhalation with signs attributed to severe bone marrow damage and associated pancytopenia; two at 138 to 144 days postinhalation with radiation pneumonitis, and three at 309 to 874 days post-inhalation with hepatic necrosis. The cumulative radiation dose to bone at time of deaths associated with bone marrow damage ranged from 710 to 1300 rads. For those that died of pneumonitis, the cumulative radiation dose to lung at time of death was 13,000 and 24,000 rads. The cumulative radiation dose to liver at time of death for the dogs that died with hepatic necrosis was 26,000 to 33,000 rads. (auth)

31908 (LF-39, pp 26-32) TOXICITY OF INHALED $^{91}YCl_3$ IN BEAGLE DOGS. II. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Studies on the metabolism, dosimetry and effects of inhaled $^{91}YCl_3$ in Beagle dogs are continuing with a view to providing information that will assist in assessing the biological consequences of nuclear accidents in which ^{91}Y may be released. Forty-two dogs with ^{91}Y burdens from 73 to 1340 μCi/kg were placed in four groups with mean initial body burdens of 120, 260, 560 and 920 μCi/kg. For comparison with observed biological effects, these same dogs were regrouped on the basis of retained 14-day body burdens yielding groups with mean values of 31, 59, 140 and 270 μCi/kg. These dogs and 12 control dogs are being maintained for lifetime observation. An additional four dogs with mean initial ^{91}Y burdens of 560 μCi/kg were placed in a sacrifice study. Eleven dogs within the highest exposure groups have died or were euthanized at 17 to 33 days after inhalation of ^{91}Y with changes related to severe bone marrow damage and associated pancytopenia. Two dogs died approximately one year after ^{91}Y inhalation with convulsive seizures that were presumed to be unrelated to the ^{91}Y exposure. Serial observations are continuing on all survivors with major emphasis directed to whole body counting, dosimetric, clinical, microbiologic, serum chemical and hematologic parameters. (auth)

31909 (LF-39, pp 33-53) TOXICITY OF INHALED ^{144}Ce FUSED CLAY IN BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Studies on the metabolism, dosimetry, and effects of inhaled ^{144}Ce in fused clay are being investigated in the Beagle dog to aid in assessing the biological consequences of release of ^{144}Ce in a relatively insoluble form such as might occur in certain types of nuclear accidents. Two major studies are being performed: a metabolism and dosimetry study in which 24 dogs are being serially sacrificed over an extended period of time, and a longevity study in which 15 dogs have been exposed to date to aerosols of ^{144}Ce in fused clay and 3 control dogs have been ex-

posed to nonradioactive fused clay. The ^{144}Ce in fused clay is retained tenaciously in the lung with only small quantities being translocated to tracheobronchial lymph nodes, liver and skeleton, however, because of the small size of the tracheobronchial lymph nodes they exceed the lung in ^{144}Ce concentration by 100 days post-inhalation. To date, 8 of the 15 dogs exposed to graded dose levels of ^{144}Ce in fused clay have died or been euthanized at 143 to 257 days after inhalation of ^{144}Ce. The prominent finding is a severe radiation pneumonitis. The cumulative radiation dose to the lung to time of death has ranged from 71,000 to 210,000 rads. The cumulative radiation dose to the lungs of survivors to 180 days post-inhalation is from 13,000 to 54,000 rads. Serial observations are continuing on all survivors with special attention directed to evaluating ^{144}Ce metabolism and dosimetry, and various clinical, pulmonary function, hematologic, serum chemical and microbiologic parameters. (auth)

31910 (LF–39, pp 54–75) TOXICITY OF $^{137}CsCl$ IN THE BEAGLE DOG. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Studies on the metabolism, dosimetry, and effects of intravenously injected $^{137}CsCl$ in the Beagle dog are being conducted to aid in assessing the biological consequences of exposure to ^{137}Cs such as might occur in the event of certain nuclear accidents. A study of the retention and tissue distribution of inhaled $^{137}CsCl$ was conducted in 31 dogs which were serially sacrificed during the first year after inhaling ^{137}Cs. ^{137}Cs was found to be ubiquitously distributed in the body thus supporting the use of whole body as the critical organ. The influence of route of administration on the metabolism of ^{137}Cs was evaluated in a study in which 5 dogs inhaled $^{137}CsCl$ and 5 were given intravenous injections of $^{137}CsCl$. Since no route effects were observed, a longevity study to evaluate the dose-response relationship for ^{137}Cs was initiated with the placement on experiment of four blocks containing 20 dogs given intravenous injections of graded doses of $^{137}CsCl$ and 4 control dogs. An additional eight blocks containing 40 dogs injected with ^{137}Cs and 8 control dogs will be placed on experiment at a later date. Eight of the 20 dogs have died; 6 at 22 to 33 days and 2 at 77 and 81 days after injection of ^{137}Cs. Death in all cases was attributed to severe bone marrow damage and associated pancytopenia. The cumulative radiation dose to whole body at time of death ranged from 830 to 1400 rads. Serial observations are continuing on all survivors with special emphasis on evaluating ^{137}Cs metabolism and dosimetry, and various clinical, hematologic, microbiologic, and serum chemical parameters. (auth)

31911 (LF–39, pp 84–91) TOXICITY OF INHALED $^{144}CeO_2$ IN RATS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

To aid in assessing the hazard associated with inhalation of radiocerium, two groups of rats were exposed by inhalation to aerosols of $^{144}CeO_2$ resulting in body burdens averaging 3.0 or 170 μCi ^{144}Ce/kg body weight. After an initial rapid clearance phase, the ^{144}Ce had an effective half-time of 100 days in lung. The cumulative β-radiation dose to that organ was 2500 rads at 500 days post-exposure, based on the average body burden at 14 days post-exposure. Radiation fibrosis of lung was found in 14 of 18 high-level rats which had died and undergone histopathologic examination. (auth)

31912 (LF–39, pp 92–103) TOXICITY OF ^{90}Sr–^{90}Y IN CHINESE HAMSTERS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

Chinese hamsters were injected with 0, 0.2, 0.5, 1.0, 2.0, 3.0, and 5.0 μCi of ^{90}Sr–^{90}Y/gram body weight and sacrificed at 2, 14, 28, 56, 113, and 224 days post-injection to assess the biological damage produced by these isotopes. A second group of animals was injected with 0 to 2.0 μCi ^{90}Sr–^{90}Y/gram body weight and maintained for long-term observation. A third group of animals was injected with ^{90}Sr and ^{88}Y to delineate the distribution of the isotopes and to aid in determining the radiation dose delivered by the ^{90}Sr–^{90}Y mixture. In the 1 and 2 μCi ^{90}Sr–^{90}Y/gram animals, survival appeared to depend on the total accumulated dose with deaths related to cellular depletion of the bone marrow. Changes in bone marrow cells included increase in number of chromosome breaks/cell as a function of dose accumulated and changes in the mitotic index. The number of chromatid plus isochromatid deletions increased with increased injected activity and the relative frequency of chromosome exchanges increased with time. Examples of cellular cloning were noted and one case of osteogenic sarcoma produced. (auth)

31913 (LF–39, pp 222–4) THE EFFECTS OF INHALATION OF $^{90}SrCl_2$ ON THE EXCRETION OF URINARY 17-KETOGENIC STEROIDS IN BEAGLE DOGS. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.).

The excretion of urinary 17-ketogenic steroids by Beagle dogs was determined before and at various times up to 24 months following ^{90}Sr inhalation. A statistically significant difference was found between sexes with female animals excreting more 17-ketogenic steroids than male animals. A large amount of variability occurred among dogs and among groups. No significant change in the excretion of urinary 17-ketogenic steroids was found that could be related to ^{90}Sr inhalation at any of the time intervals studied to date. (auth)

31914 (UR–49–1098) AGE SENSITIVITY OF THYROID RADIATION IN THE DOG. Quinlan, W. J.; Michaelson, S. M. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Apr. 25, 1969. 8p. (CONF-690501–5). Dep. CFSTI.

From 9th Annual Hanford Symposium on Radiation Biology of the Fetal and Juvenile Mammal, Richland, Wash.

Sixteen beagles, 3 to 22 months of age, were given 1800 or 1000 R of x radiation to the thyroid gland at a dose rate of 50 to 100 R/minute. All exposures were carried out with a 1000 KVp x ray machine. In the adults a dose of 1800 R localized to the thyroid gland resulted in a depression in protein-bound iodine (PBI) level and radioactive iodine uptake (RAIU) from 1 to 24 months after exposure. None of the dogs responded to exogenous thyroid stimulating hormone (TSH) administration 12 months after irradiation. In puppies that received the same dose of radiation to the thyroid gland, there were increases in PBI, RAIU, and free thyroxine (T4) values during the first 3 months following exposure. At 7 months, however, all of these thyroid parameters were depressed. None of the puppies responded to TSH at 7 and 21 months after exposure. Adult beagles exposed to 1000 R localized to the thyroid showed little change in RAIU or PBI up to 11 months after exposure although a decrease in PBI became evident at 11 months in some animals. The puppies showed an increase in PBI values between 4 to 11 months after exposure to 1000 R. After 11 months the PBI level returned to normal. The RAIU remained within normal limits through the 20 months post-irradiation observation period. There was a good response to TSH at 4 and 9 months but none of the dogs responded to TSH stimulation at 20 months following exposure. When these thyroid results are compared with the results acquired on beagles exposed to 1800 or 1000 R upper-body x irradiation there appear to be some differences. At 1800 R upper-body x irradiation there is no alteration in thyroid function within the first 12 months following exposure. In puppies exposed to 1800 R to the upper body, there is no change in thyroid function up to the time of death at 3 months after exposure. A dose of 1000 R to the upper body has little effect on thyroid function in any of the beagles regardless of age up to 1 year after exposure. (auth)

31915 SPECIFIC PHARMACOLOGICAL ACTION OF CERTAIN NARCOTIC AGENTS IN THE CASE OF RADIATION INJURY. Saksonov, P. P.; Kozlov, V. A. Voenno-Med. Zh., No. 10, 40–4 (Oct. 1968). (In Russian).

Among other injurious effects, ionizing radiation caused changes in the regulatory functions of the nervous and endocrine systems; this affected the reaction of the irradiated organisms toward medicinal preparations. These changes must be taken into account in the therapy of radiation sickness, during which the victims may require the administration of anesthetic agents. Dogs, cats, guinea pigs, rabbits, rats, and mice were used for the examination of the behavior of the animals suffering only from γ- or x-radioinduced radiation sickness and also from burns, wounds, and fractures. The tests indicated that at the start and toward the climax of radiation sickness, the sensitivity toward barbiturates increased; the usual doses caused a deeper and longer-lasting narcosis; the sensitivity toward ethyl ether exhibited a similar increase. Administration of nitrous oxide did not result in changed effects. Spinal and rectal anesthesia should not be used in case of radiation sickness; local anesthesia was usually indicated. Radioprotective agents, such as mercaptoalkylamines and cystamine hydrobromide, were found to enhance the narcotic effect of hexanol, making it possible to reduce the dose required for surgery. (TTT)

31916 EXPERIMENTAL METHODS FOR EVALUATING THE HEMATOLOGICAL EFFECTS OF IRRADIATION. Perussia, A.; Martinenghi, C. (Univ., Milan). Med. Nucl.-Radiobiol. Lat., 11: 83–98(1968).

The hematological effects of irradiation were studied experimentally by means of different methods including the use of radioisotopic techniques. Some of these methods, especially developed for this investigation, are briefly illustrated, and their theoretical basis, technical details, and information possibility are discussed. The absolute and relative numerical variations of the circulating (leukocytes) and the structural alterations of the nuclei of the most radiosensitive cells (thymocytes and lymphocytes) are considered as a function of the absorbed dose. Granulocytic dynamics were studied by means of phosphorus-32-tagged di-isopropyl-

fluoro-phosphate and the erythropoietic function with selenium-75-tagged methionine. The incorporation of mercury-197-tagged bromo-mercury-hydroxy-propane into the red blood cells was used for exploring the hemocatheretic function and the erythrocyte resistance. The results of the experimental use of these methods in γ irradiated (rabbits and rats) are reported and discussed. (auth)

31917 THE THYMUS: A HEMATOPOIETIC ORGAN. I. THE AGE AND THE SEASON AS DETERMINING FACTORS. Schneiberg, Krzysztof; Jonecko, Antoni; Bartnikowa, Wieslawa (Laboratoire d'Analyses Cliniques et d'Hematologie, Gliwice, Poland). Folia Haematol. (Leipzig), 88: 253-9(1967). (In French).

Thymectomy in a 3-week-old mouse brings about an important reduction of the animal's natural resistance to a whole-body ionizing irradiation. The same operation is no more effective when performed in a 3-month-old mouse. Young mice only born in the semester winter-spring were shown to exhibit such a thymus-dependent radiosensitivity. In animals born in summer-autumn this radiation-mortality-enhancing effect of thymectomy in the same age was not observed. Thus, an additional influence of season on biological functions of thymus in mouse must be postulated. Attention is called to this point for all experiments dealing with thymus. (auth)

31918 ACTION OF ULTRAVIOLET RAYS IN THE PRESENCE OF CHLORPROMAZINE ON THE BLOOD IN EXTRACORPOREAL CIRCULATION. Carraz, G.; Beriel, H.; Boitard, M.; Lebreton, S.; Dardas, A. (Faculte de Medecine, Grenoble, France). Agressologie, 9: 465-7(1968). (In French).

A photosensitizing effect of uv radiation was demonstrated by showing the presence of an active molecule in irradiated systems. In an in vitro system employing Ehrlich ascites carcinoma cells irradiated by a mercury vapor lamp, lactic acid production was increased as a function of uv irradiation time. In the presence of 0.01 mg/ml chlorpromazine, lactic acid production was increased 70%. The combined action of uv radiation and chlorpromazine was also demonstrated in rabbits subjected to extracorporeal circulation. Chlorpromazine was introduced into the irradiation chamber at a level of 10 mg/ml. Irradiation caused no change in respiration, arterial pressure, plasma proteins, or red cells but caused neutropenia and lymphocytosis that was prolonged two to three fold by the presence of chlorpromazine, and an increase in granulocytes. Similar experiments were conducted on chickens with leukosis virus. (BBB)

31919 GROWTH OF TRANSPLANTED MURINE TUMORS IN PREIRRADIATED SITES. Hewitt, H. B.; Blake, E. R. (Mount Vernon Hospital, Northwood, Eng.). Brit. J. Cancer, 22: 808-24 (Dec. 1968).

The volume growth of bone rapidly growing and slowing growing murine sarcomas was reduced in the subcutaneous tissue of mouse legs previously exposed to a single dose of 2000 R of 250 kV x rays, compared with the rate in the contralateral unirradiated legs. Growth restraint was similar in legs irradiated 7, 17, 26, and 62 days before injection of tumor cells. No restraint was observed with an interval of 350 days, but restraint was again apparent when the interval was extended to 450 days. A bi-phasic effect of preirradiation was proposed. The growth-restraining effect of preirradiation was exerted equally in mice aged 3 to 4 and 12 to 21 months. Preirradiation of the site of injection of tumor cells had no influence on the latent phase of subsequent tumor growth. This limitation of the effect to later phases of growth was associated with ability of microtumors to grow independently of vascularization. Subcutaneous injection of two strains of murine leukemia cells did not lead to a local tumor in preirradiated or control sites. The latent period before development of generalized leukemia was similar after injection into irradiated and control sites. No restraint of tumor growth was detected in sites preirradiated with lower doses (100 or 500 R). The minimum effective dose was between 500 and 1000 R, and in the range 1000 to 4000 R the effect was similar. (BBB)

31920 VASCULO-CIRCULATORY FACTOR IN THE CENTRAL NERVOUS SYSTEM PATHOGENESIS OF THE X-RAY POSTIRRADIATION EFFECTS. Roizin, L.; Machek, J.; Liu, J. C.; Cavaness, W. C.; Carsten, A. L. Trans. Amer. Neurol. Ass., 93: 270-2(1968).

Monkeys (Macaca rhesus) were x-irradiated on the right occipital region at a dose rate of 300 to 350 rad/min up to a total dose of 3500 R. Prior to and following irradiation the functional integrity of the visual cortex was examined with photo-evoked response technic. The left side served as a control. One group of six monkeys was sacrificed four weeks postirradiation and a second group of six monkeys twelve weeks postirradiation. Before sacrificing, animals were infused with Evans blue and fluorescein isothiocyanate. Macroscopic and microscopic examinations of the brain were made after four weeks and after twelve weeks. Nissl stain disclosed moderate to pronounced perivascular cellular reactions on the irradiated side. The fluorescent technics revealed various degrees of abnormal penetration of the dye into the perivascular tissues and surrounding areas on the irradiated side. It was concluded that the character and severity of the lesions depended upon the frequency and duration of the irradiation, the biological characteristics of the experimental model, and the duration of the experimental investigations. (H.L.W.)

31921 EFFECTS OF DOSE AND OF PARTIAL-BODY EXPOSURE ON CONDITIONING THROUGH A RADIATION-INDUCED HUMORAL FACTOR. Hunt, E. L.; Carroll, H. W.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Physiol. Behav., 3: 809-13(Nov. 1968).

In parabiotic rat pairs united by a chronic skin-vascular anastomosis, a conditioned aversion to saccharin was established in the radiation-shielded member of the pair following exposure of its partner to 360 R of x rays. The humoral motivating factor induced by irradiation was studied by testing the saccharin-aversion conditioning of the shielded recipient member for its dependence on both the body region and the dose of irradiation received by the exposed donor partner. Irradiation of one member of the parabiotic rat pair served to motivate a conditioned aversion to saccharin-flavored fluid in its completely shielded partner. The induction of a circulating humoral factor acting as a noxious stimulus was investigated further. The degree of conditioning of saccharin aversion in the shielded partner was significantly reduced with exposure of the irradiated member to a lower dose of 180 R. No evidence of conditioning was obtained when the irradiated member was exposed to 180 or 360 R when the head or the remainder of the body was shielded. It was concluded that induction and transfer of the humoral factor resulted from effects produced in both regions of the body and were not related simply to the mass of tissue exposed. Loss of effectiveness of irradiation in the exposed member, because of circulatory pooling of the humoral factor with the shielded partner, was also investigated. A marked conditioned aversion to saccharin was obtained in the irradiated member with a 12-R exposure only when its partner was equally exposed and dilution by pooling was precluded. It was concluded that a 12-R exposure induced a humoral factor which was diluted by circulatory pooling with a shielded partner. (BBB)

31922 RADIOSENSITIVITY OF THE LYMPHOCYTES WITHIN THE GUT EPITHELIUM. Fichtelius, K. E. (Argonne National Lab., Ill.). Acta Pathol. Microbiol. Scand., 75: 27-32(1969).

Radiosensitivity of gut epithelium lymphocytes, called theliolymphocytes, was studied. The cells were obtained from mice exposed to 300 R from ^{60}Co γ radiation. The number of ^{3}H-thymidine labeled cells in duodenum was counted 6 hr to 8 days later. The normal number of theliolymphocytes per 2000 epithelial nuclei was ~200 or close to 10% of the total in Feulgen-stained material. In animals killed 12 and 24 hr after irradiation the numbers of theliolymphocytes were decreased, the means being 140 and 139 respectively per 2000 epithelial nuclei. The number of labeled theliolymphocytes 30 min to 1 hr after injection of ^{3}H-thymidine showed great variation and no certain pattern could be seen. The number of labeled theliolymphocytes 15 to 16 hr after injection of ^{3}H-thymidine showed a minimum value 12, 24, and 48 hr after irradiation, ~3 labeled cells per 400. The highest figure, 24.9 on day 8 after irradiation, was significantly higher than these lower values. The results show that theliolymphocytes are as radiosensitive as blood lymphocytes. The unknown stem cell of theliolymphocytes seems to be radioresistance. (BBB)

31923 EXPERIMENTAL PERITONITIS IN IRRADIATED RABBITS. Schildt, B. (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Chir. Scand., 135: 61-6(1969).

Experimental peritonitis was induced in healthy and irradiated animals to compare the value of conservative vs radical treatment as judged by mortality rate. Radiation sickness was produced in rabbits by 850-R irradiation with 280-kV x rays, and peritonitis by ileal loop obstruction and venous ligation. Results indicated that peritonitis in an animal simultaneously suffering from acute radiation sickness is satisfactorily treated by early elective surgery and administration of antibiotics and whole blood. Mild peritonitis, causing no deaths among controls, proved to be a heavy strain on sublethally irradiated animals. When it was inflicted 5 days postirradiation, the mortality, compared to that of nonirradiated controls, rose significantly. The same significant increase of the death rate occurred following severe peritonitis in irradiated compared to nonirradiated animals. The irradiated animals' increased sensitivity to infection lasted for several weeks postirradiation. Elective surgery undertaken within 2 to 3 days after the infection starts was the therapy of choice. Antibiotics

and blood transfusions were valuable therapeutically. Provided that adequate treatment was given, the prognosis for the irradiated rabbits was good in mild peritonitis, but poor in severe peritonitis. (BBB)

31924 RADIOSENSITIVITY OF OOCYTES IN POSTNATAL GUINEA PIGS. Ioannou, J. M. (Univ. of Birmingham, Eng.). J. Reprod. Fert., 18: 287-95(Mar. 1969).

The guinea pig differs from other rodents in that the ovary of the postnatal animal contains two distinct populations of oocyte at diplotene. A large oocyte, comparable to that of other mammals, is found in some primordial follicles; in others a second, contracted type occurs. As the animal ages the contracted cell predominates. The radiosensitivity of these two cell types was investigated in 98 animals that received unilateral ovarian x irradiation (300 to 15,000 R). The numbers of germ cells in the irradiated ovary were counted from 3 to 32 days later, and compared with those found in the untreated, contralateral ovary of each animal. Irradiation killed large oocytes, and induced contracted cells either to degenerate or undergo transformation to the large nuclear type. Contracted oocytes were consistently and significantly more sensitive to irradiation, even over a short (3 days) postirradiation interval. Over a longer interval (16 or 32 days) a dose-dependent response was revealed: the higher the dose, the smaller the number of surviving oocytes. Although the $LD_{50/32}$ for oocytes in primordial follicles was as low as 500 R, 15,000 R was required to eliminate all the oocytes. (auth)

31925 DIRECT AND INDIRECT EFFECT OF X IRRADIATION ON CONDITIONED AVOIDANCE BEHAVIOR. LeVan, H.; Moos, W. S.; Hebron, D. L. (Univ. of Illinois, Chicago). Med. Exp., 18: 161-8(1968).

The possible effects of irradiated saccharin sodium and sucrose solutions on avoidance behavior were studied in CFW mice. Animals were allowed 10 days to establish a preference of saccharin to tap water, and on the 11th day x-irradiated (2000-R) saccharin replaced the regular solution the mice had been drinking. On day 12 the average saccharin consumption dropped from 60 to 48 ml or about 30% difference from the previous average daily saccharin intake by 10 mice. On the 14th day nonirradiated saccharin solution again substituted the irradiated one, with fast recovery of saccharin preference. On the 16th day, a fresh solution of saccharin exposed to 2000 Rad replaced the previous one, but almost no decrease in consumption was observed at this time. The degree of avoidance of saccharin varied with the x-ray dose absorbed by the solution, up to 5000 Rad. One day after the introduction of x-irradiated sucrose (5000 Rad), the average daily sucrose intake dropped to 45% compared to previous days and stayed at this level until the 3rd day when nonirradiated sucrose was offered. On the next day the sucrose consumption increased to normal. It is concluded that mice avoid both saccharin and sucrose when these solutions are irradiated. Whether the nature of this behavior is the same as that observed when the animals themselves are exposed to radiation is unknown. (BBB)

31926 EFFECTS OF RADIATION AT WEANING ON GROWTH OF INBRED AND HYBRID MICE. Nash, Donald J. (Colorado State Univ., Fort Collins). Growth, 32: 297-310(Dec. 1968).

How changes in body weight that occur after whole-body irradiation may be used not only to detect radiation effects but also to detect possible genetic differences was explored. A complete diallel cross, including inbreds and reciprocals, was made among three inbred lines of mice (SWR/J, C3H/HeJ, and C57BL/6J). Ten mice of each sex of the nine cells of the diallel cross were subjected to x irradiation doses of 0, 50, 100, 200, and 400 R (total of 900 mice). Growth response, as measured by changes in body weight, was followed through 9 weeks of age. Changes in gross body weight were effective in detecting differences in response to sublethal levels of irradiation. All irradiated mice, as well as controls, continued to gain weight after irradiation, but growth rate was lessened by doses above 50 R. Growth rate changes were maximal 2 weeks after irradiation. Significant differences in growth were observed between the sexes, among the inbred strains, and between inbred and hybrid genotypes. Generally, maternal and sex linkage effects on growth were small. Evidence of some genotypic differential growth response to irradiation was revealed by significant Dose X Inbreds and Dose X General Combining Ability interactions. Body weight response following irradiation was similar in both inbred and hybrid populations, but hybrids tended to recover more quickly than the inbreds from the initial decreased weight gain. Radiosensitivity, as measured by growth changes, following sublethal levels of irradiation appears to vary with age during the period from birth to sexual maturity. (BBB)

31927 COMPARATIVE EFFECTS OF PURIFIED DIETS AND A NATURAL FOOD STOCK RATION ON THE TUMOR INCIDENCE OF MICE EXPOSED TO MULTIPLE SUBLETHAL DOSES OF TOTAL-BODY X-IRRADIATION. Ershoff, B. H.; Bajwa, G. S.; Field, J. B.; Bavetta, L. A. (Univ. of Southern California, Los Angeles). Cancer Res., 29: 780-8(Apr. 1969).

Studies were made of the effects of multiple sublethal doses of whole-body x irradiation (six weekly exposures of 200 R each) on the subsequent appearance of tumors in female mice fed either highly purified diets or a natural food stock ration. Six months after the first x-ray exposure, mice fed the purified diets showed a markedly higher incidence of a number of tumors (lymphosarcoma of the mandibular lymph nodes, lymphosarcoma of the thymus, uterine adenocarcinoma, Harderian gland adenocarcinoma, and others) over that of similarly x-irradiated mice fed the stock ration. Nonirradiated mice of similar age fed identical diets were virtually free of such tumors. The protective factor or factors in the natural food stock ration is apparently distinct from any of the known nutrients. (auth)

31928 PATHOMORPHOLOGY OF THE LUNGS IN EXPERIMENTAL RADIATION SICKNESS IN RABBITS. Szczurek, Zbigniew; Habczynska, Danuta (Academy of Medicine, Katowice, Poland). Med. Pracy, 18: 478-83(1967). (In Polish).

Histological studies were made of lungs of 35 rabbits of which 30 were exposed to 160-kV x rays at doses of 200 to 1000 R. The observed changes included: atelectasis, inflammatory signs, circulatory disorders, and vascular alterations. The exacerbation of these alterations increased with the increase of the dose of radiation and decreased in the course of radiation sickness. The inflammatory changes were the most severe and were characterized by interstitial pneumonia. They developed from atelectasis and hyaline membrane formation and may lead to permanent respiratory insufficiency. These experimental findings are discussed in regard to pathologic processes in the lungs of patients after thoracic radiotherapy. (BBB)

31929 AGE CHANGES IN THE BEHAVIOR OF MONKEYS INDUCED BY IONIZING RADIATIONS. Boer, Arend P.; Davis, Roger T. (Univ. of South Dakota, Vermillion). J. Gerontol., 23: 337-42(July 1968).

Comparisons of the freely occurring behavior of irradiated rhesus monkeys and their controls were made in living cages at three periods during the life-span. The first observations in 1952 provided baselines before exposure to whole-body radiation; the second observations were made seven yr later in 1959 after a sample of experimental animals had been exposed to repeated doses of x rays. The last observations were carried out in 1966. Of 10 experimental monkeys, six survived three periods of whole-body x irradiation with 400, 400, and 300 R doses each. The gross behavior of the two groups was studied to detect the possibility of acceleration or mimicry of aging-like changes induced by irradiation. Monkeys showed remarkable changes in spontaneous behavior as a function of age and prior radiation. Aging trends were not augmented by irradiation effects. Age-related changes involved less social behavior, less manipulation of inanimate objects, changes in vision, and more self-directed behavior with advancing age. Rapid energy expenditure did not decline in frequency but probably in intensity. Differences between the previously irradiated monkeys and their controls in social behavior were not in the same direction as the aging effects and not caused by selective survival. (BBB)

31930 SORPTION OF AN ACTIVE DYE: PROCION BRIGHT RED: BY INNER ORGAN TISSUES OF WHITE RATS SUBJECTED TO A STRONG IRRADIATION. Dolgov, E. G. Tsitologiya, 11: 462-8(Apr. 1969). (In Russian).

A study was made of the interaction between an active dye, procion bright red, and tissues of inner organs (liver, kidney, small intestine, spleen, brain, heart muscle, adrenal gland) of white rats following 6 hours, and 1, 3, 5, 7, 10, 15, 20 and 30 days after a single whole-body x-irradiation with a 400 R dosage. The irradiation was found to result in increasing the dye sorption by majority of tissues examined, the sorption being characterized mainly by covalent bonds. The peak of abnormal dye sorption occurred within 5 to 10 days after irradiation. By the 20th day the sorption is getting normalized in all the above tissues except small intestine and spleen. The sorption of a nonextracted fraction of the dye by the latter tissues is seen normalized only by the 30th day of the postirradiation period. The changes discovered may be due to some serious structural reorganization of cytoplasmic complexes effected by ionizing irradiation. (auth)

31931 INFLUENCE OF IONIZING RADIATION ON SEROTONIN IN TISSUES OF RATS. Goncharenko, E. N.; Subbotina, S. M.; Alieva, L. I. (Moscow State Univ.). Biol. Nauki, No. 7, 61-5(1968). (In Russian).

The results of a study of the variation of the content of total, free and bound serotonin in the tissues of irradiated animals (1,000 Rads) at various intervals (30 minutes and 2, 24, 48 and

72 hours after irradiation) were presented. After 30 minutes and 2 hours total serotonin increased 30 to 50% over the initial level in all tissues examined (intestine, stomach, liver and brain). In the intestine, stomach and liver this increase was brief and was replaced by a substantial and stable reduction. Only in the tissue of the brain did the amount of total serotonin remain above the norm in the terminal period of acute radiation injury. A study of the redistribution of free and bound forms of serotonin at various intervals showed that in almost all tissues examined, with the exception of the liver, the content of the free form of serotonin increased over the norm. In the intestine and brain the increase began even in the initial period of the development of the injury, while in the stomach tissues it began later, in the terminal period. This process was observed even when the total amount of serotonin in the tissues decreased sharply, i.e., in the terminal period. Almost immediately after irradiation the capacity of certain tissues to bind serotonin began to decrease. This was true for intestinal tissues while only a tendency to decrease was noted for stomach tissues. A still greater decrease in capacity to bind serotonin was noted in the terminal period of radiation injury (10% in the liver and 16 to 20% in the gastrointestinal tract). Brain tissue was the exception. In these experiments no substantial change in the capacity of the tissue to bind serotonin was observed. It was concluded that the reduction of the relative content of the bound form of serotonin, particularly in the terminal period of the injury, depended on the change in the capacity of tissues to bind serotonin. (JPRS)

31932 PNEUMOSCLEROSIS IN RATS AFTER INTRATRACHEAL ADMINISTRATION OF SOLUBLE ^{239}Pu COMPOUNDS. **Koshurnikova, N. A.; Lemberg, V. K.; Nifatov, A. P.; Pozyrev, A. A. Gig. Tr. Prof. Zabol., No. 11: 27-32(1968). (In Russian).**

Data on the frequency and severity of pneumosclerosis in rats dying at remote intervals after intratracheal administration of various doses of soluble plutonium compounds are presented. Solutions of plutonium nitrate (pH 2.0, doses from 0.00042 to 1 microcurie), sodium plutonyl triacetate (pH 6.5, dose 1 microcurie) and a 0.01N solution of nitric acid were administered once intratracheally in the amount of 0.3 ml. Only beginning with a dose of 0.42 microcurie did the rats poisoned with plutonium live a shorter subsequent life than the animals receiving only nitric acid. When plutonium was introduced in doses of 0.048 to 1 microcurie a reliable increase in the frequency of pneumosclerosis (83 to 94%) over that of animals poisoned only with nitric acid was observed. Even with a dose of 0.01 microcurie the sclerotic process in the lung of the experimental animals became more severe and widespread. Histoautoradiographic investigation of the lungs of the rats showed irregular distribution of the isotope at remote intervals after administration of various doses of nitric acid and sodium plutonyl triacetate. The largest amount of large aggregates of plutonium was located in scar tissue in the region of the radix pulmonis. The injury of the structural elements of lung tissue in rats of all experimental series was more pronounced than injury of the lymph tissue of the lungs and the regional lymph nodes. (JPRS)

31933 SKELETON BONE CHANGES IN CHICKENS AND HENS AS THE RESULT OF RADIOACTIVE STRONTIUM INTOXICATION. **Kirshin, V. A. Uch. Zap. Kazan. Vet. Inst., 98: 240-8(1967). (In Russian).**

One hundred fifty White Russian chickens, aged 24 hr to 2 months, were given a peroral daily dose of ^{90}Sr at 9×10^{-5} (total dose 0.416 μCi) or 6×10^{-2} (278 μCi total) μCi/g of body weight. These two groups and a control group were maintained separately, but on the same diet. The shape and size of femoral, rib, sternal, and tibial bones were determined. Radiograms of bones of dead animals were compared with radiographs of bones of living animals. The results are described. The first group that was followed from 24 hr to 30 months of age showed some signs of radiation disease in clinical and hematological examination. The second group of birds showed signs of acute and even fatal radiation disease; the extent of damage was dependent on dose. Slow growth and bone deformation were noted. When the ^{90}Sr was stopped, regeneration of bone began, growth accelerated and at 6 months of age, the length of bone approached normal. Solidity of bones usually decreased, but occasional increases were found. (C.O.)

31934 EFFECTS OF X-IRRADIATION WITH RELATION TO ABNORMAL MORPHOGENESIS. **Murakami, Ujihiro (Nagoya Univ., Japan). Senten Ijo, 8: 147-62(Sept. 1968).**

Pregnant mice of the ddN-JCL and CF #1-JCL were exposed to 200 or 300 R doses of x radiation by various methods. Two groups of malformations were manifested by x-irradiation upon the mouse embryo in the early stage of development. Malformation incidences of groups generally presented only one peak: arhinencephalia or malformations of the extremities. Malformations such as hydrocephalus, hypoplastic malformations of the eye, cleft palate, malformations of the tail, and malformations of the vertebra presented di-phasic elevations of frequencies in the ddN strain; there was only one such elevation in the CF #1 strain. It was concluded that the first peak of incidence may represent a very indirect effect, i.e., influences on the inductory system, ancestral cells of the prospective organs, or on the primordium just prior to its formation; the second peak may represent a direct effect upon the primordium of some of the organs themselves. Such di-phasic peaks of incidence, as seen in the sensitive periods of development, revealed two morphogenetic processes for one trait. The first manifestation of indirect effect was subtle. Generally, such an indirect effect probably resulted in suppression of the organ primordium just prior to its formation. The first direct damage of the organ primordium was well defined. The apparent differences in sensitivity were not necessarily the result of differences in sensitivity to primary radiation damage. Generally, in the CF #1 strain, development proceeded a little earlier than in the ddN strain. (NSA of Japan)

31935 AN EXPERIMENTAL STUDY ON THE EFFECT OF X-RAY IRRADIATION AGAINST MALIGNANT TUMOR. ESPECIALLY, ABOUT RADIOSENSITIVITY OF EXTRACTED TUMOR DUE TO THE DIFFERENT TEMPERATURE OF CIRCUMSTANCE. **Yamamoto, Munekazu (Tokyo Medical Coll.). Tokyo Ika Daigaku Zasshi, 26: 405-37(July 1968). (In Japanese).**

Tumors were kept at room temperature (26°C) or at temperatures of 22 or 4°C before exposure to doses of 1,000, 1,500, or 2,500 R x radiation and transplantation into experimental animals. The rate of growth of the transplanted tumors was measured during a 30-day period. Growth was impaired in tumors exposed to 1,500 and 2,500 R at room temperature more than in those exposed at lower temperatures. It was concluded that environmental temperature affects the radiosensitivity of tumor transplants. (TSS) (NSA of Japan)

31936 EXPERIMENTAL STUDIES ON THE EFFECT OF X-RAY IRRADIATION IN THE CARCINOMA. **Morishita, Masaaki (Osaka Univ.). Osaka Daigaku Shigaku Zasshi, 13: 139-49 (June 1968). (In Japanese).**

A transplanted carcinoma growing in rabbits was exposed to 1,500 R x radiation and histological and enzymatic studies were made. The tumor showed a reduction in size three days following irradiation and cytological studies showed necrosis of tumor cells. Changes in the activity of six enzymes were observed immediately following irradiation. It is suggested that changes in enzyme activity may be used to evaluate the effectiveness of x radiation therapy in malignant tumors. (TSS) (NSA of Japan)

31937 AN EXPERIMENTAL STUDY ON THE EFFECT OF X RAY AGAINST MALIGNANT TUMOR. WITH SPECIAL REFERENCE TO THE GROWTH AND TRANSPLANTATION-RATE DUE TO THE DIFFERENCE OF TOTAL OF IRRADIATION. **Akiya, Shoji (Tokyo Medical Coll.). Tokyo Ika Daigaku Zasshi, 26: 335-72(July 1968). (In Japanese).**

The effects of doses of x radiation ranging from 500 to 3,000 R on the rate of growth of subcutaneously transplanted sarcomas in mice were measured at various times up to 30 days following irradiation. The growth of the tumor was markedly suppressed following exposure to 2,000 R. The effects of a single dose of 3,000 R were compared with the effects of 1,000 R given daily for three days, 1,000 R given every third day to a total dose of 3,000 R, and 1,500 R given twice in one day. Results showed that 3,000 R delivered as a single dose had the greatest suppressive effect on tumor growth. (TSS) (NSA of Japan)

31938 AN EXPERIMENTAL STUDY ON THE INFLUENCE OF X RAY AGAINST MALIGNANT TUMOR. **Hirabayashi, Yukio (Tokyo Medical Coll.). Tokyo Ika Daigaku Zasshi, 26: 307-33 (July 1968). (In Japanese).**

The effects of doses of 1,000, 2,000, and 3,000 R x radiation on the rate of growth of subcutaneously transplanted sarcomas in mice were measured at various times up to 30 days following irradiation. All the doses used caused a decrease in tumor size. A dose of 3,000 R caused a 90% decrease in size by the 30th day. (TSS) (NSA of Japan)

31939 THE EFFECT OF IONIZING RADIATION ON THE FINE STRUCTURE OF SYMPATHETIC NEURONS OF THE FROG. **Pick, J. (New York Medical Center, N. Y.). Acta Neuroveg., 30: 404(1967). (In German).**

Changes in the fine structure of sympathetic neurons of adult frogs 1 hr to 2 weeks after whole-body x irradiation with doses of 1000 R were reported. The most prominent effects were observed in the lysosomes and similar bodies. These formed aggregates. Vacuoles formed in the Golgi membrane. Degeneration and clumping of mitochondria, and fat droplets and multivesicular particles were observed in the axons of the nerve fibers. Large, dense, glycogen-type granules appeared in the presynaptic fibers. The

degree of changes observed was not proportional to the doses administered or the interval between irradiation and microscopic study. The changes varied between animals, different neurons of the same animals, and different portions of the same neuron. It was concluded that the reactions observed may have been caused by changes in membrane permeability or glycogen metabolism. (BBB)

31940 EFFECTS OF IONIZING RADIATION UPON THE IMMATURE RABBIT LARYNX. Bonte, Frederick J.; Stembridge, Vernie L.; Reef, James D. (Univ. of Texas, Dallas). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 791-4(Apr. 1969).

Laryngeal hypoplasia may be produced by irradiating immature rabbit larynxes with single doses of 800 to 1,924 R, exposures biologically comparable to those which the larynxes of a number of children receiving external beam radiotherapy for carcinoma of the thyroid gland might have sustained. If the changes of hypoplasia have been produced in humans, they seem not to have been significant enough to give signs, or symptoms, or otherwise to have been noted in the appraisal of these cases in the several thyroid tumor registries. However, because of the possible late consequences of mucous membrane epithelial metaplasia, such as carcinogenesis, it would seem wise to ensure that a child who has had major radiotherapy in, or about, his larynx, be seen periodically by competent physicians for the rest of his life. (auth)

31941 EFFECTS OF RADIATION ON RODENT AND HUMAN OVARIES. Lindop, Patricia J. (Medical Coll. of St. Bartholomew's Hospital, London). Proc. Roy. Soc. Med., 62: 144-8(Feb. 1969).

In this review the end-points which can be used to test ovarian radiosensitivity are described, and the definition of cell death is discussed in terms of population decrease. Both cell population decrease and functional decrease can be plotted against the dose of radiation using the log of the surviving fraction. This exponential relation allows D_0, or the reciprocal of the slope of the linear portion, to be used for comparison of sensitivities. Oocyte death as one end-point of radiation damage is considered. The effect of irradiation on oocyte depletion rates depends on the age at exposure as the proportion of each type of cell changes. For example, with fetal rats a very rapid change in cell number occurs depending on the age at exposure to 100 Rad, as measured by cell survival at 25 days after birth. Mice made hypoxic by nitrogen gain some protection against irradiation so that higher doses are required to produce the same rate of depletion. For the immature cells there is an exponential dose response curve, with D_0 in the region of 8.5 Rad in air and 24 Rad in nitrogen, which agrees well with other LD_{50} estimates for small oocytes of 8 Rad. Functional impairment, in terms of reproductive lifespan and reproductive capacity, is much less affected by radiation than would be predicted from the cell depletion. Another point which gives much the same result as reproductive capacity is shortening of the reproductive lifespan. A summary of the age sensitivity as seen in the D_0 values for these end-points is shown. The apparent resistance of the neonatal ovary and the marked sensitivity at 2½ weeks old correspond with an acute peak of sensitivity following a single dose of 20 or 25 Rad. The sensitivity is less than would be predicted from cell survival data. (BBB)

31942 INTESTINAL BLOOD FLOW IN GASTROINTESTINAL IRRADIATION SYNDROME IN THE RAT. Janossy, Gy. (Univ. Research Team of Medical Radiology, Budapest). Acta Med. Acad. Sci. Hung., 26: 13-21(1969).

The possible role of postirradiation circulatory changes in aggravating mucosal cell injury and impairing regeneration was investigated. Adult male Wistar rats received a 1500-R whole-body dose of x rays, and hemodynamic studies were made by the ^{86}Rb extraction and other methods. Four hr after irradiation a significant reduction in peripheral resistance (increase in cardiac output) was demonstrable. Vasodilatation was more intensive in the small intestine than generally in the vascular system, as the small intestine fraction of blood flow increased. The normal blood flow gradient of the small intestine declined by the end of 24 hr. At 48 hr there was a reduction in the absolute blood volume flowing through the small intestine; this reduction did not, however, exceed the weight reduction of the organ. At 24 and 48 hr the large intestine showed marked vasodilatation. At 72 hr there was a significant constriction in the splanchnic region exceeding that in the rest of the organism, without a change in cardiac vascular resistance. The circulatory changes which had developed by 72 to 76 hr inhibited the regeneration of the intestinal mucosa. (BBB)

31943 ELECTRON MICROSCOPY OF ARTICULAR CARTILAGE OF MICE: RESPONSE TO HYPOTHYROIDISM PRODUCED RADIOTHYROIDECTOMY WITH ^{131}I. Silberberg, Ruth (Washington Univ., St. Louis); Hasler, Mary. Arch. Pathol., 87: 502-13(May 1969).

Hypothyroidism caused by thyroid injury with ^{131}I caused profound disturbances in the course of endochondral ossification at the growth zones of tibia and femur and produced severe joint disease in mice thus treated. An investigation of the ultrastructural changes occurring in articular chondrocytes of mice, that had their thyroid glands injured by radioiodine, was made. The animals received an intraperitoneal injection of 20 or 25 μCi/g body weight of ^{131}I, and were killed 2 or 4 days, or 1, 2, or 4 weeks thereafter. Mice given ^{131}I gained weight more slowly than untreated controls. Growth of chondrocytes and development of nuclei and of cytoplasmic organelles were retarded. The inhibition involved endoplasmic reticulum and the Golgi apparatus, also the deposition of glycogen, and thus, the formation of large hypertrophic chondrocytes. Preexisting hypertrophic chondrocytes, on the other hand, did not undergo the rapid disintegration usually associated with advancing ossification. Calcification of the matrix was only slightly retarded submicroscopically, although the total amount of Ca precipitated was considerably decreased. These effects of hypothyroidism were thus diametrically opposed to those observed after administration of thyroxine. The subcellular findings suggest disturbances of protein synthesis, mitochondrial functions, and metabolism of polysaccharides. Coinciding with regeneration of thyroid tissue, regular chondrocytes reappeared, while the matrix continued to show evidence of injury. (BBB)

31944 HAEMOGLOBIN PRODUCTION IN MICE RECOVERING FROM RADIATION. Lord, B. I.; Schofield, R. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London), 221: 1060-2(Mar. 15, 1969).

The studies reported suggest that during induced recovery in lethally irradiated mice the normal balance of haemoglobin synthesis is disturbed and that erythropoiesis under these conditions may have little in common with normal erythropoiesis. The studies were made on haemoglobins extracted from cells actively synthesizing the protein in bone marrow and spleen, using electrophoresis on starch gels; details of the ^{59}Fe labeled haemoglobin analysis are given. The mice were irradiated whole body with 850R x-rays, followed by an intravenous injection of either normal bone marrow or normal spleen cells, and spleen colonies were taken after 10 days. It was found that the distribution of ^{59}Fe was identical in both the spleen and the bone marrow. It was difficult to make direct comparisons between haemoglobin being synthesized and that already synthesized, and because of this only measurements in the organs synthesizing haemoglobin were considered. It was significant that the haemoglobins may polymerize differently, depending on their source. Haemoglobin electrophoretograms are shown, indicating erythropoietic recovery as a result of the injection of either bone marrow or spleen cells. Differences between the response in marrow and spleen are marked. It is concluded that different erythropoietic patterns arise depending on whether recovery is effected by bone marrow or by spleen, and on whether recovery is observed in the spleen or bone marrow. Neither source of cells appears to produce a normal distribution of haemoglobins even when developing in its own natural environment, and the most frequently used combination of bone marrow cells developing in spleen colonies gives a distribution furtherest removed from the normal pattern. (UK)

31945 COMPARATIVE STUDIES OF LUNG CHANGES IN THE RABBIT FOLLOWING THORAX IRRADIATION WITH 200 KV X-RAY, ^{60}Co γ RADIATION, AND 17.3 MeV ELECTRONS. Kranz, D.; Kunz. J.; Degner, W. (Humboldt-Univ., Berlin). Frankfurt. Z. Pathol., 76: 361-9(1967). (In German).

Rabbits received a single dose to the thorax of 2000 to 1200 R either by conventional x-radiation, 17.3 MeV electron radiation, or cobalt-60 γ radiation. Doses between 2000 and 3000 R were followed by severe histopathological changes in the lungs after a latent period of several months. Effects caused by the different types of radiation were essentially alike. (tr)(H.B.G.)

31946 THE EFFECTS OF WHOLE- OR PARTIAL-BODY 1000 kVp X-IRRADIATION ON THE BONE MARROW OF THE DOG. II. PRELIMINARY ^{59}Fe UPTAKE MEASUREMENTS. Maille, H. D.; Quinlan, W. J. Jr.; Mermagen, H.; Michaelson, S. (Univ. of Rochester, N. Y.). Health Phys., 16: 345-8(Mar. 1969). (UR-49-941).

The uptake of ^{59}Fe citrate in the bones of control and irradiated dogs was used as an index of the distribution of hematopoietic function. An animal exposed to 100 R whole-body 1000 kVp x irradiation showed a shift in ^{59}Fe uptake from the ribs to the long bones. This finding is in agreement with previous dosimetric studies. Dogs subjected to partial-body irradiations showed a decreased ^{59}Fe uptake in directly exposed bones, with increased uptakes in shielded bones which depended upon the distance of such bones beyond the edge of the shield, again in agreement with dosimetric studies. It is suggested that variations of this

method may be useful in using the exposed animal as its own dosimeter. (auth)(UK)

31947 THE EFFECTS OF WHOLE- OR PARTIAL-BODY 1000 kVp X-IRRADIATION ON THE BONE MARROW OF THE DOG. I. INTRAMEDULLARY DOSE MEASUREMENTS. Maille, H. D.; Quinlan, W. J. Jr.; Mermagen, H. (Univ. of Rochester, N. Y.). Health Phys., 16: 341-4(Mar. 1969). (UR-49-940).

Studies were performed in which intramedullary doses were measured throughout a large dog cadaver. The data will be used as the basis for live animal studies in which hematopoietic function will be measured using radioactive tracers. In the partial-body studies it was noted that intramedullary dose beyond the edge of the shield was a function of distance from the shield and was unrelated to the type of bone involved. (auth)(UK)

31948 REDUCTION OF THE RADIATION INJURY TO RATS BY MEANS OF ERYTHROPOIETIN IN CASE OF SUBTOTAL IRRADIATION. Klestova, O. V. (Central Roentgenologico-Radiological Scientific Research Inst., Leningrad). Dokl. Akad. Nauk SSSR, 184: 463-5(Jan. 11, 1969). (In Russian).

It was shown before that partial exposure to radiation results in the enhancement of the positive effect of shielding part of the body if the blood production is stimulated after irradiation. This was studied by using erythropoietin as a stimulant. The 200 rats used for the experiment were divided in to four groups: exposed to total irradiation; shielding the rear end of the animals; total exposure to 750 to 800 R after injection of erythropoietically active blood serum extract and for partial exposure and injection of the above extract into the animals. The results indicated that the erythropoietin increased the survival rate of the animals only if it was used in rats which were partially shielded during the exposure. The shielding ensured that the animals possessed some uninjured blood-producing tissue. The presence of erythropoietin did not have any effect in the totally irradiated animals. These observations confirm earlier reports in the literature; the lack of effect in case of exposure to lethal doses is caused by the fact that no blood-forming cells that could be stimulated to survive. (TTT)

31949 THE OCULAR EFFECTS PRODUCED BY EXPERIMENTAL LASERS. IV. THE ARGON LASER. Campbell, Charles J. (Columbia Univ., New York); Rittler, M.; Catherine; Swope, C. Hermas; Wallace, Robert A. Amer. J. Ophthalmol., 67: 671-81(May 1969).

Photocoagulation experiments were carried out on the eyes of chinchilla and albino rabbits with a continuous wave argon ion laser. The coagulations were studied both clinically and histologically. The data indicate that, at relatively low power settings, the lesions are similar to those produced by the xenon-arc photocoagulator. At higher power settings, the lesions developed hemorrhagic characteristics resembling those produced by the ruby laser. The coagulations are small in size and appear to represent firm chorioretinal adhesions. The small size is advantageous in some clinical situations but the ruby laser seems to be equally adequate in these areas for the production of chorioretinal adhesions. However, the focal nature of the coagulations and the absence of profound and devastating ocular damage indicates that a properly controlled argon laser may be employed in photocoagulation with safety. There is sufficient theoretical basis for further exploration of the effects of this laser especially on the retinal vasculature. (auth)

31950 RADIOBIOLOGICAL SYMPOSIUM AND FIFTH ANNUAL MEETING OF THE EUROPEAN SOCIETY FOR RADIATION BIOLOGY, BEDRICHOV, CZECHOSLOVAKIA, SEPTEMBER 4-8, 1967. Stud. Biophys., 2: 1-284(1967). (CONF-670975).

Abstracts of the papers presented at the symposium in Czechoslovakia in 1967 are presented. The papers include investigations on the effects of radiation on plants and animals at all levels of organization from molecular to organismic. An author index is included. (E.R.B.)

31951 PRELIMINARY REPORT ON VIRUS-LIKE PARTICLES IN A TRANSPLANTABLE RAT MAMMARY CARCINOMA. Engle, G. Caroline; Shirahama, Shigekuni; Dutcher, Ray M. (Inst. for Medical Research, Camden, N. J. (Univ. of Pennsylvania, Philadelphia). Contract PH 43-65-65. Cancer Res., 29: 603-9(Mar. 1969).

Tumor, thymus, spleen, and plasma from rats inoculated with an x-irradiation-induced transplantable rat mammary carcinoma were examined with the electron microscope at various intervals following transplantation. Virus-like particles were found in all tumors at 15 or more days after transplantation but were not observed in the thymus, spleen, and plasma, or in tumors examined earlier than 15 days. The particles were morphologically of the C-type, having a diameter of from 95 to 110 mμ. The significance of these virus-like particles and their relationship to the transplantable rat carcinoma is unknown. (auth)

31952 ERYTHROCYTE AGE: DENSITY: VOLUME RELATIONSHIPS IN NORMOBLASTIC AND NON-NORMOBLASTIC ERYTHROPOIESIS. Coopersmith, Alan. Rochester, N. Y., Univ. of Rochester, 1968. 302p.

Thesis.

Experiments are described which were designed to determine the age : density : volume relationships of dog erythrocytes produced under four different erythropoietic conditions: normoblastic erythropoiesis, non-normoblastic erythropoiesis (following acute blood loss), erythropoiesis following acute temporary blood loss, and erythropoiesis following acute blood loss in old and old-irradiated dogs. A blood fractionation tube especially designed for these experiments is described. The results of the experiments are interpreted in light of classical and proposed concepts of red cell production. The density of normal dog erythrocytes increases as the cells age, although there is no significant alteration in the cell volume during ageing. The volume distribution of normal erythrocytes of all ages in bimodal (in both a synthetic medium and autologous serum), indicating two populations of red cells in peripheral blood. The bimodality of the volume histograms is related to antecedent mitotic history of individual erythrocytes. It is suggested that normoblastic erythropoiesis is a proliferating cell system in which the majority of erythrocytes mature from orthochromatic normoblasts produced following five cell divisions; concomitantly, other erythrocytes are produced from orthochromatic normoblasts produced following four mitotic divisions. Cells produced by each of the two maturation sequences comprise the two populations seen in the normal histogram. Alterations in the relative size of the two populations serve as a sensitive indicator of altered erythropoiesis. Erythrocytes produced in response to acute blood loss (macrocytes) are characterized by increased cell volume, decreased life-span (life-span of 21 days as compared to the accepted value of 100 days for normocytes), and saltatory increases in cellular density during in vivo ageing. The mean cell volume (MCV) of macrocytes is approximately twice normal. The production and influx of macrocytes into the peripheral blood alters the volume histogram. The second cell population increases in size, all newly produced cells are as large as normal second population erythrocytes, and some cells with volumes even larger than normal second population erythrocytes are produced. Shifts to the right (toward larger volume) in the volume histogram are attributed to skipped mitotic divisions of precursor cells. The response of animals to periods of anemia induced by temporary acute blood loss for five or three hours is characterized by moderate increases in the percent reticulocytes in the whole blood and by small but significant increases in the MCV of newly released erythrocytes. In contrast to the response to acute blood loss (i.e., alteration in the kinetics of cellular proliferation), it is suggested that short-term anemia causes alteration in the pattern of cell release of already-formed erythrocytes, rather than alteration in the mode of cell production. The response of old and old-irradiated dogs to acute blood loss is characterized by an exaggerated and accelerated macrocytosis. In addition, the rate of recovery from blood loss is slower in these animals than it is in younger, non-irradiated dogs. The differences between the responses of old-irradiated dogs and younger normal dogs to acute blood loss are interpreted as reflecting effects of ageing and of residual radiation damage of the stem cell pool. A mathematical model of normocyte and macrocyte production is presented and discussed. (Disser. Abstr.)

31953 THE MORPHOLOGY AND GROWTH CHARACTERISTICS OF RADIATION-INDUCED EPITHELIAL SKIN TUMORS IN THE RAT. Albert, R. E.; Phillips, M. E.; Bennett, P.; Burns, F.; Heimbach, R. (New York Univ.). Cancer Res., 29: 658-68 (Mar. 1969).

The histology of radiation-induced epithelial skin tumors in the albino rat is described in terms of various types of nondifferentiated, sebaceous, and keratinized tumors. The frequency distribution, growth rate, and time of onset of these tumors are shown to be related to the magnitude of residual skin damage. Tumors are shown to form periodically with peak rates in the domain of 20, 40, and 60 weeks after irradiation. Evidence is presented which suggests that the structure of skin tumors is explained in terms of their origin from atrophic follicles. (auth)

31954 INHIBITING EFFECT OF IRRADIATION ON GYNECOMASTIA INDUCED BY ESTROGEN HORMONE STIMULATION: AN EXPERIMENTAL STUDY. Alfthan, Olof S. (Univ. of Helsinki). J. Urol., 101: 905-8(June 1969).

The purpose of this study was to obtain more precise knowledge of the inhibitory effect of x ray in preventing gynecomastia induced by estrogen treatment. Male rabbits were castrated and given 0.5 mcg. estrone in arachis oil, intramuscularly once a day, for 150 consecutive days. The rabbits were divided into 6 groups according to the time of irradiation in relation to the commencement of estrogen therapy. The right mammary glands were irradiated once

with 1,000 R or 3 times (at intervals of a week) with 750 R. When the x-ray treatment was given prior to estrogen therapy its effect persisted despite continued stimulation with estrogen hormone. The results confirm and extend previous clinical experience on the inhibitory effect of roentgen treatment on gynecomastia induced by estrogen hormone. (auth)

31955 HISTOCHEMICAL DEMONSTRATION OF CARBOHYDRATES IN GUINEA PIG BRAIN AFTER IRRADIATION WITH FAST ELECTRONS (17 MeV). Arndt, B. (Univ., Hamburg); Lierse, W.; Franke, H. D. Fortschr. Geb. Roentgenstr. Nuklarmed., 110: 564-9(Apr. 1969). (In German).

Twenty-four hrs after irradiation of the skulls of guinea pigs with 17 MeV electrons (750 to 2,500 R), it was possible to demonstrate extra-cellular carbohydrate accumulations measuring 10 to 70 μ histochemically in the white matter; the larger foci contained glycogen centrally and mucopolysaccharides, mucoproteins, glycoproteins, and glycolipids peripherally. These were found particularly in the corpus callosum, the white matter of the frontal and occipital poles, and in the cerebellum. Their distribution depended on the dose; after 1,000 to 2,000 R the number of foci increased, but they then contained little mucopolysaccharides. After 14 days, protein-carbohydrate complexes could barely be demonstrated, the protein components being absorbed more quickly than the polysaccharides. Seventy-four days after 1,000 R, there was deposition of glycogen in the oligodendrocytes and along the axons; the demonstration of glycogen was regarded as a sign of glia insufficiency and may later lead to damage of the white matter. (auth)

31956 INFLUENCE OF VARIOUS DOSE X-IRRADIATION ON THE DILUTE SPERM CONSERVED AT LOW TEMPERATURE. Mkrtchya, S. A. Biol. Zh. Arm., 22: No. 2, 101-2 (Feb. 1969). (In Russian).

Data obtained on 500 to 1500 R dose irradiation of rabbit sperm diluted and preserved at low temperature did not produce any negative effects on the activity, resistance, and survival of spermatazoids examined 6 hr after exposure. The survival of six month old rabbit progenies of such spermatozoids was 75%, at 500 R dose, 69.2% at 1000 R, 58.3% at 1500 R and 61.5% in the controls. (R.V.J.)

31957 ACTIVITY OF ALKALINE AND ACID PHOSPHATASE IN GANGLION CELLS FOLLOWING X RADIATION OF GUINEA PIG BRAIN. Wrage, Dieter; Lierse, Werner; Franke, Herbert D. (Univ., Hamburg). Strahlentherapie, 137: 320-5(Mar. 1969). (In German).

Thirty-five guinea pigs were administered x ray doses of 500 to 2000 R to the head. Histochemical studies of the phosphatases in the ganglion cells were done between the 1st and 18th day. Regional differences are observed in the reaction of the acid phosphatases; the reaction is more marked in the grey substance than in the white, and in the grey matter more in the cortical zone than in the central zone. According to the glycogen, the frontal region seems more sensitive. The variation of the acid phosphatases (after 500 to 750 R) is biphasic, the second phase (13th to 15th day) being more pronounced, than the first one. With higher doses (1000 to 2000 R) the second phase is earlier (6th to 7th day). The alkaline phosphatases are only moderately depressed, depending on the dose and the time of study. (auth)

31958 HISTOCHEMICAL INVESTIGATION OF THE MUCOSA OF THE EXTERIORIZED SMALL INTESTINE OF THE RAT EXPOSED TO X-RADIATION. Jervis, Helen R.; Donati, Robert M.; Stromberg, LaWayne R.; Sprinz, Helmuth (Walter Reed Army Medical Center, Washington, D. C.). Strahlentherapie, 137: 326-43(Mar. 1969).

Irradiation of the exteriorized small intestine of rats with 2000 R x rays, the rest of the body being shielded, results in a discontinuous mucosal injury of varying intensity, ranging from mild crypt lesions repaired in 2 days of extensive ulcerations. Even in the absence of severe morphologic changes at the light microscopic level during the first two days after radiation, the enzymatic activity of the epithelial cells is altered and absorption from the lumen and synthesis of sulfated mucins in the goblet cells are depressed. Suppression of histochemically demonstrable enzymatic activity in the absorptive cells is associated with severe pathologic changes. Regeneration in the more severely affected areas begins at 4 to 5 days after exposure and, in rats which do not succumb to the acute intestinal radiation syndrome, is still incomplete 4 weeks after irradiation. In these areas radiation may effect the regenerative cells of the crypts leading to an increase in cell size, and to gross irregularities of the mucosal structure. The mucosal enzymatic functions and the absorption of lipids remain depressed and sulfation of mucin is impaired. (auth)

31959 THE EFFECT OF ^{60}Co IRRADIATION ON BONE IN DOGS. PART II. GROWING BONE. Rissanen, Pentti; Rokkanen, Pentti; Paatsama, Saki (University Central Hospital, Helsinki. Coll. of Veterinary Medicine, Helsinki). Strahlentherapie, 137: 344-54(Mar. 1969).

The effect of ^{60}Co irradiation on the bone of growing dogs was studied by histological, histochemical, OTC bone labeling methods, auto- and microradiography. Single doses of 250, 500, 1000, and 2000 rad were used. The dogs were sacrificed after four days, two weeks, and two months. Incipient degenerative changes were observed in the epiphyseal cartilage 4 days after irradiation with 500 rad and larger doses. The extent of the changes was directly proportional to the magnitude of the dose. Two weeks after irradiation the bone trabeculae showed a decrease in density and erosions, obviously signifying a decrease in mineral content. At the same time poorly mineralized areas were seen, interpreted as a sign of beginning of regeneration. It thus appears that the microstructure of the bone is not resistant to irradiation, since the bone had not returned to normal two months after irradiation. (auth)

31960 HISTOLOGICAL STUDIES AFTER EXPERIMENTAL GRID IRRADIATION: STATE OF BONE MARROW AND OF GUERIN TUMOR. Unger, Emil (Frederic Joliot-Curie Staatlichen Forschungsinstitut fuer Strahlenbiologie und Strahlenhygiene, Budapest). Strahlentherapie, 137: 355-66(Mar. 1969). (In German).

Histological changes found in the bone marrow of rabbits and rats as well as in the Guérin-tumor of rats following homogeneous, slot- and grid-irradiation, are described. Although a sharp margin between damaged and relatively intact zones is rare, since the gravely damaged zones turn into less damaged ones continuously, the pattern may be identified histologically in an appreciable part of the cases, both after slot- and grid-irradiation. In the bone marrow the margin of the damaged zone adjusts itself very often to the trabecula. In the Guérin-tumor the clearness of the pattern decreases with the time elapsed after irradiation. It is assumed that the intact tissue volumes exert some protective effect on the irradiated ones. (auth)

31961 EFFECTS OF RADIOINDUCED METABOLISM DISTURBANCES ON ABSORPTION OF p-AMINO-HIPPURATE AND TISSUE RESPIRATION OF RAT KIDNEYS. Bargon, Gerlach; Moench, Helga (Univ., Goettingen, Ger.). Strahlentherapie, 137: 367-74(Mar. 1969). (In German).

The mechanism of radiation in the renal tubular cells, slices of the renal cortex from rats, irradiated unilaterally homogeneous irradiation at 100 kV, dose of 3000 R), were studied. The absorption and concentration of tubular cells for para-amino-hippurate (PAH) was investigated, after an incubation of 120 min in a PAH-solution, and also the oxygen consumption after a 30 min stay in a Warburg-apparatus. Two days after the irradiation, a significant decrease of the PAH absorption and of the concentration gradient is observed in the kidney slices as well as of the oxygen consumption. During an 8-day observation period, the PAH-concentration, the concentration gradient, and the respiration coefficient decreases continuously. The reduction of the PAH-absorption and of the oxygen consumption in the slices after irradiation can be regarded as an expression of a radiation induced metabolic disturbance in the tubular cells. The radiation induced function disturbance in the early phase of the lesion is not caused primarily by cellular death nor by reduction of the tubular cell number, but is caused by a disturbance of the metabolism in the surviving tubular cells. (auth)

31962 WATER INTAKE AND URINE OUTPUT IN RELATION TO THE SURVIVAL OF X-IRRADIATED RATS. Deanovic, Zivan; Supek, Zlatko (Inst. Rudjer Boskovic, Zagreb). Strahlentherapie, 137: 375-8(Mar. 1969).

In the midlethally irradiated rats (800 R ≅ LD 60) a negative water balance appeared on the second post irradiation day. Dehydration paralleled the severity of radiation sickness. In spite of increased diuresis, gravely affected rats excreted urine of higher specific gravity. Thus, diminished water uptake associated with polyuria of high osmotic density probably was caused by large production of radiation-induced catabolites in the severely sick animals. In the less affected rats, dehydration was significantly lower and water uptake was normal. (H.B.G.)

31963 CHANGES IN PLASMA CORTICOSTERONE IN COMBINED TRAUMA. von der Nahmer, D.; Sprenger, E. Z. Gesam. Exp. Med., 145: 99-105(1968). (In German).

Male mice were subjected to single traumas such as ether anesthesia, skin wounds, and whole-body x irradiation at 250 R. In all animals the plasma corticosterone level showed a brief initial elevation with a following decrease to the corresponding values of normal. The combined trauma consisted of a skin wound followed by whole-body x irradiation at 250 R. The interval between the two traumas was 24 and 96 hr. The plasma

corticosterone level showed a higher and longer elevation after the 24-hr interval between the traumas. The plasma corticosterone level rose from a basal level of 8 μg/100 ml to a maximum of 34 μg/100 ml 60 min after 250 R irradiation alone, to 25 μg/100 ml after irradiation 25 hr post-wounding, and to 21 μg/100 ml after irradiation 96 hr post-wounding. The decrease in mortality reported earlier in combined injuries with an interval of 24 hr could be explained by the elevated level of plasma corticosterone. (BBB)

31964 STEROID SECRETING CAPACITY OF X-IRRADIATED RAT OVARIES. Macdonald, Gordon J.; Keyes, P. Landis; Greep, Roy O. (Harvard Medical School, Boston). Endocrinology, 84: 1004-8(May 1969).

Rats were unilaterally ovariectomized and pituitary-autotransplanted during metestrus, and 7 to 13 days later the remaining ovary was exposed to 3000 R of x irradiation to destroy follicles. Corpora lutea and interstitial tissue showed no discernible histologic evidence of abnormality following x irradiation. After treatment with PMS no follicular development was observed, and there was no indication of estrogen secretion as evidenced by the absence of stratification of vaginal epithelium. Estradiol caused stratification and mucification, but not cornification, indicating that the x-irradiated ovary continued to secrete progesterone. In animals that were mated prior to pituitary autotransplantation and x irradiation, injections of LH failed to induce implantation although implantation occurred following subsequent treatment with estradiol. Thus, following destruction of all follicles by x rays the rat ovary continued to secrete progesterone, indicating follicles were not required for this luteal function. Under the same conditions, no estrogen secretion of physiological significance occurred in response to PMS or LH. (auth)

31965 ACTION OF TARGET GLAND HORMONES ON PITUITARY TSH REBOUND: VALIDATION OF THE THRESHOLD HYPOTHESIS OF TSH SECRETION. D'Angelo, S. A. (Jefferson Medical Coll., Philadelphia). Endocrinology, 84: 632-40(Mar. 1969).

Asynchronism was induced in production and release of TSH in young and old female rats by feeding propylthiouracil (PTU) in the diet (.1–.15%) for 32 to 450 days and withdrawing the goitrogen for 7 to 10 days before autopsy. PTU treatment consistently lowered TSH concentration in the adenohypophysis and increased plasma titers of the hormone (stasis tadpole method of assay). Withdrawal of the goitrogenic stimulus resulted in substantial reaccumulation of TSH in the pituitary to supranormal levels; plasma TSH levels usually decreased but still remained in the elevated range. Adrenal gland weight and corticosteroid content of plasma and adrenal were invariably decreased in the hypothyroid rat. No significant correlation was apparent between the status of pituitary-adrenocortical function and the shift in TSH secretion after cessation of PTU treatment. Dexamethasone administration, hemiadrenalectomy or placement of median eminence lesions in goitrous rats, all failed to inhibit pituitary TSH rebound following withdrawal of PTU. Attempts to block pituitary TSH repletion by inhibiting protein synthesis with puromycin also failed. Estradiol benzoate (50 μg daily, 8 to 9 days) partially inhibited TSH reaccumulation in the hypertrophied pituitaries of female rats. Results obtained from surgical and radiothyroidectomy indicated that the TSH rebound phenomenon does not occur in the absence of the thyroid. Complete surgical removal of the goiter prior to discontinuation of PTU treatment markedly inhibited TSH repletion in the adenohypophysis. Partial thyroidectomy was ineffective. Pituitary TSH rebound was completely inhibited in rats made athyreotic by combined surgical and radiothyroidectomy. The administration of a small dose of thyroxine (.6 μg daily, last 7 to 8 days) to PTU treated rats (50 days) produced a substantial increase in pituitary TSH content without reduction in plasma TSH or alteration in goiter size. Conversely, a single injection of 1 mCi of ^{131}I to normal rats resulted in sharply reduced pituitary TSH content and elevated plasma hormone levels, and almost complete destruction of the thyroid. It is concluded that the pituitary TSH rebound phenomenon is a direct consequence of the functional activity in the unblocked thyroid gland. (auth)

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Refer also to abstracts 31671, 31718, 31765, 31766, 31768, 31816, 31830, 31865, 31872, 31877, 31883, and 31950.

31966 (A-AC-82/G/L-1264) EFFECTS OF IONIZING RADIATION ON THE NERVOUS SYSTEM. PART I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1968. 72p. (In Russian). Dep.

A separate abstract was prepared for each of the five papers presented. (C.O.)

For abstracts of individual papers see: 31967–31971.

31967 (A-AC.82/G/L-1264, pp 3-10) PRINCIPLES OF THE CLINICO-PHYSIOLOGICAL EVALUATION OF THE HUMAN NERVOUS SYSTEM IN THE CASE OF IRRADIATION. Gus'kova, A. K.; Barabanova, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

The effects of radiation on the nervous system, as on other organs, consists of irritation and injury; no clear-cut correlation could be established between the radiation acting as an irritant and certain nonspecific reactions resulting from the exposure. The structural changes followed the basic laws of radiation injury to regenerative processes; they are observed in the nervous system only if the dose is sufficiently high. The three fundamental, successive syndromes of radiation sickness are: disturbance of the nervous-visceral control; asthenia; and rarely occurring organic injury to the central nervous system. Recent studies indicate that changes in the nervous system caused by exposure to radiation are usually of functional nature; they are unstable, reversible, and not specific for radiation sickness. It is proposed that earlier data be subjected to a strict critical statistical evaluation. The statistically meaningful results must be supported by clinical observation of syndromes on more radiation-sensitive organs. (TTT)

31968 (A-AC.82/G/L-1264, pp 11-30) CLINICO-PHYSIOLOGICAL CHARACTERISTICS OF THE NEURO-CIRCULATORY DYSTONIC SYNDROME IN RADIATION SICKNESS. Denisova, E. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

Clinical observations were carried out to evaluate the radiation level and the dynamics of the clinical indicators of persons subjected to the combined action of x, γ, β and neutron radiations. The high sensitivity of the cardiovascular and neuro-vegetative systems toward radiation indicates that the circulatory hemodynamic changes observed in chronic radiation sickness have an etiological character; lately, they have been designated as neurocirculatory dystonia. Hypotonic neurocirculatory dystonia may also be caused by certain occupational factors, such as contact with organic solvents, lead, or exposure to high temperatures. Observations with personnel at the Joint Institute for Nuclear Research, the cyclotron laboratory of the Institute for Physics, and research reactor staff were reviewed. It was found that although the syndrome is not specific for radiation exposure, it follows the same development. There is an initial change in the hemodynamic indicators, representing the physiological response of the organism to radiation. Further increase of the dose results in the appearance of the neurocirculatory dystonia syndrome, characterized by headaches, arterial hypotension, bradycardia, changes in the vascular tone, disturbances in the blood circulation, electrocardiographic perturbances, increased myocardiac excitability, and biochemical changes. (TTT)

31969 (A-AC.82/G/L-1264, pp 31-48) FUNCTIONAL STATE OF THE HEART AND CONTROL OF ITS ACTIVITY IN THE CASE OF CHRONIC EXPOSURE TO IONIZING RADIATION. Saitanov, A. O. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

Earlier electrocardiographic studies were reviewed to determine the functional load and to estimate the regulatory activity of the heart, attempting to evaluate the radiation-induced changes. Observation of persons exposed to radiation revealed that a few of them exhibited initial changes in the functional state of the heart upon exposure to 70 rem of x radiation for a period of 5 to 10 years or to phosphors for a total dose of 60 to 200 rem for 10 to 20 years, i.e., 4 to 5 times the maximum permissible dose during the first years of special occupation. Experimental studies with animals revealed that incorporated radioactive cobalt or iron at total doses exceeding the maximum permissible level by a factor from 10 to 100 causes changes in the central nervous system of the heart, including an increase during the first 6 to 12 months and a decrease after 18 to 22 months of the cardiac-vagus reflex. This was attributed to changes in the sensitivity of the central nervous system, the adreno-reactive and the choline-reactive myocardiac systems. The reaction of the organism to radiation is manifested in part through changes in the electrolytic balance of the myocardium. The clinical electrocardiographic changes are not specific for radiation. (TTT)

31970 (A-AC.82/G/L-1264, pp 49-62) SOME CHANGES OF THE CEREBRAL HEMODYNAMICS IN THE CASE OF EXPOSURE TO IONIZING RADIATION. Kirsanova, G. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

The literature on the effects of ionizing radiation on the vascular system of the brain and studies on the cerebral hemodynamics of persons afflicted with neurocirculatory dystonia resulting from radiation exposure are reviewed. Dilation of the vessels and changes in their walls were noted by early authors. The pa-

tients complained of headaches, dizziness and similar symptoms. Somato-neurological examinations revealed that the arterial pressure was not steady and the neurological symptoms were also variable. The cerebrovascular tone was reduced in 63% and increased in 23% of the cases. Patients suffering from neurocirculatory dystonia, exposed to a total dose near the maximum permissible level did not exhibit changes in the cerebrovascular tone. Therefore, the neurocirculatory dystonia which has been considered a nonspecific reaction of the organism to ionizing radiation, does not depend on the total radiation dose but has a characteristic clinical syndrome. (TTT)

31971 (A-AC.82/G/L-1264, pp 63-72) ENCEPHALOGRAPHIC STUDIES ON PERSONS EXPOSED TO LOW RADIATION DOSES. Sosnovskaya, F. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

The nervous system of persons with vegetative vascular dystonia after chronic exposure to ionizing radiation was examined on the basis of previously published papers which indicated that the bioelectric processes are greatly affected by radiation. The cases were followed up after the completion of the therapy. The study covered 30 individuals who received less than the maximum permissible dose and 35 others whose total exposure after 15 to 20 years of work reached 150 to 400 rem. It was concluded that the bioelectric activity of the brain of persons subjected to occupational exposure does not differ markedly from the standard. Persons with diagnosed chronic radiation sickness exhibited fast oscillations in their spontaneous bioelectric activity. The response to photostimulation of persons with hypotonic neurocirculatory dystonia was found to be weakened; in many cases, the response to hyperventilation was also affected. The majority of persons exposed to total doses of 10 to 400 R in 5 to 20 years did not exhibit gross disturbances in the functional state of the cortex; this agreed with electroencephalographic observations on patients suffering from acute radiation sickness. (TTT)

31972 (CONF-690509-1) PSYCHOLOGICAL ASPECTS OF ACUTE RADIATION ACCIDENTS. Bunin, Sanford M. (Hanford Environmental Health Foundation, Richland, Wash.). [1968]. 9p. (SM-119/24).

From Symposium on the Handling of Radiation Accidents, Vienna, Austria.

Three phases of the accident problem are described. The pre-injury phase is concerned with the predisposition of the worker toward his work in general and toward radiation in particular. This phase plays a major part in his potential for an accident as well as in his response to the treatment for an accident. The second, or reactive phase includes a transient reactive state characterized by muscular tension, nausea, and feelings of apprehension and irritability. Later symptoms of the second phase are described as the situational anxiety state, the moderate reactive phase, and the severe reactive phase. The third, or aftermath, phase is concerned with the patient's problems of coping with his family, friends, community, the professional staff, and job security. Psychological considerations for treatment include development of a stable environment, reestablishment of frames of reference, provision for dynamic environment which includes feedback and challenge, personal concern for the patient, and helping the patient to maintain his self-image. (H.L.W.)

31973 (NYO-3970-20) SIGNIFICANCE OF MEDICAL X-RAY DIAGNOSTIC EXPOSURE IN RELATIONSHIP TO THE MENSTRUAL CYCLE AND THE FETUS. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). Jan. 15, 1969. Contract AT(30-1)-3970. 13p. (CONF-690111-1). Dep. CFSTI.

From 4th Meeting of the X-Ray Image Production and Related Facilities Advisory Committee, Las Vegas, Nev.

Data are reviewed from radiobiological, epidemiological, and clinical studies on the effects of low radiation doses on the maturation of the developing mammalian ovum and fetus. It is pointed out that data from radiation experiments on lower animals are limited and cannot be extrapolated with any precision to humans and that no experimental data are available on the genetic and somatic effects of the small doses of x radiation received by the patient during diagnostic radiography on pregnant females or developing ova and fetuses. Experimental difficulties in the effective design of reliable clinical studies are discussed. It is concluded that the possibility of pregnancy should be considered when radiographic examinations of women of childbearing age are contemplated and that, since the early stages of pregnancy are the most radiosensitive, the radiation exposure of the pelvic region of young women should be as low as is consistent with adequate diagnosis in each individual case. (C.H.)

31974 EFFECTS OF LOCALIZED RADIATION ON THE HEAD. Gus'Kova, A. K.; Abdulaeva, V. M.; Novikova, L. V.; Sokolina, L. L. Med. Radiol., 14: No. 5, 26-32 (May 1969). (In Russian).

An x-ray technician who was accidentally exposed to a 10,000 R dose to a localized part of the head was under observation for one and a half years. An experiment on a phantom of the skull was carried out and the absorbed doses for individual structures of the brain, eye, and mucous membranes determined. Changes were observed in the mucous membrane, skin, eye, nerves, and bone. The changes were compared with those reported in the literature. (auth)

31975 A CLINICAL PICTURE OF MULTIPLE MALFORMATIONS ACCOMPANIED BY ACQUIRED CHROMOSOME CHANGES: A PATHOGENETIC MECHANISM CAUSED BY IRRADIATION. (PRELIMINARY COMMUNICATION). De Toni, E.; Massimo, L.; Vianello, M. G.; Dagna-Bricarelli, F. (Univ. of Genoa). Panminerva Med., 8: 419-20 (Nov. 1966).

A female infant with multiple malformations and with acquired chromosome changes in the leukocytes referable to the action of x and uv irradiation of the mother during the previous 12 yr and in the first 7 months of her pregnancy is reported. Gross features at 18 months included hypertelorism with exophthalmos, low siting of the ears, short neck, and pubic lanugo. Chromosomal abnormalities included chromosomal agglutination and lysis, lesions of the chromatin in one or both of the chromatids, chromosomal fragmentation and the formation of ring chromosomes and bridges in which several chromosomes ceased to have separate identity and formed various combinations between themselves. The rearrangement that caused these formations had taken place during prenatal life. (BBB)

31976 ELECTROENCEPHALOGRAPHIC STUDIES ON THE INFLUENCE OF RADIOTHERAPY OF BRAIN TUMORS ON THE ACTION OF THIOPENTAL IN HUMANS. Mensikova, Z.; Visnovsky, P.; Skarda, M. V.; Grossmann, V.; Kubicek, J.; Rozsival, V.; Petr, R. (Charles Univ., Hradec Kralove, Czech.). Anaesthetist, 18: 77-82 (Mar. 1969). (In German).

It was previously determined that the response to thiopental is prolonged in irradiated animals, especially after head irradiation. Electroencephalographic (EEG) studies were conducted in 10 patients receiving head irradiation and thiopental. Pre-irradiation surgery of brain tumors was carried out in all cases. After the operative wounds had healed, doses of 750 to 4000 R were given. Sensitivity to thiopental (2 or 3 mg/Kg intravenously) was tested after doses of about 1500, 2500, 3500, and 4500 R were reached. The EEG results and the clinical reaction before irradiation were compared with the reaction during the course of irradiation with increasing doses, three to five experiments being carried out in each patient. The patients had supratentorial tumors, namely glioblastomas (3), proliferating astrocytomas (3), oligodendrogliomas (2), and tumors of the basal ganglia (2). Sensitivity to thiopental was evaluated from the EEG. The rapidity of onset, intensity, and duration of EEG changes produced that frequently consisted of pronounced delta waves of the type of intermittent frontal delta rhythms were studied. ECG and breathing were monitored and the instant of patient waking was observed simultaneously. Sensitivity to thiopental after irradiation of brain tumor was found to be increased, since the EEG reaction was more intensive and prolonged. The results were similar to the earlier experiments on animals that showed an increase in the sensitivity to thiopental after head irradiation. (BBB)

31977 STUDY ON THE FUNCTION OF ADRENAL CORTEX UNDER THE ^{60}Co TELE IRRADIATION AFTER AN OPERATION FOR CARCINOMA CANALIS CERVICIS. Yoshikawa, Shinji (Nihon Univ., Tokyo). Nippon Sanka Fujinka Gakkai Zasshi, 21: 125-34 (Feb. 1969). (In Japanese).

Though excellent clinical effects of ^{60}Co teletherapy on carcinoma canalis cervicis are widely recognized, serious problems remain concerning the side effects caused by this mass irradiation. The adrenal cortex is very sensitive to radial rays, so the effects of ^{60}Co teletherapy on the function of the adrenal cortex in a carcinoma canalis cervicis patient were investigated. As for the adrenal cortex function testing method, excretion of 17-hydroxycorticosterone (17-OHCS), 17-ketosteroid (17-KS), aldosterone, cortisol, estrogen, and pregnanediol in urine, and increases in the ratio and amounts of 17-KS and 17-OHCS after ACTH loading were determined as follows; 17-OHCS decreased as irradiation was applied, especially after ACTH loading. 17-KS had a tendency to decrease slightly but not distinctly, and no definite tendency was found in its reaction by ACTH loading. Large changes were not observed for aldosterone, and definite tendencies were not found for estrogen or pregnanediol, both having very low values. Therefore, the decrease in the reserve function of the adrenal cortex induced by ^{60}Co γ irradiation was determined by a reduction of reactivity by the 17-OHCS method especially after ACTH loading. (NSA of Japan)

31978 CONCERNING THE CHANGES IN THE WHITE CELL CONTENT IN PATIENTS WITH CANCER OF THE UTERINE NECK AS A RESULT OF THE COMBINED RADIATION THERAPY.

Kholin, V. V. (State Postgraduate Medical Inst., Leningrad. Central Research Roentgenological Inst., Leningrad). Vop. Onkol., 15: No. 1, 32-6(1969). (In Russian).

The combined radiation therapy in cervix uteri cancer was accompanied by regular development of leukopenia. At the moment of cessation of treatment leukopenia of some degree was noted in 62% of patients. With equal values of the exposure total dose, inhibition of leukopoiesis was more pronounced among patients who received x-ray therapy than among those who were treated by gamma-rays of radioactive cobalt. X-irradiation is accompanied by more pronounced increase of the integral absorbed dose. Similarly, with equal integral absorbed dose, markedly greater number of patients with leukopenia is observed among those who were x-irradiated. (auth)

31979 ALOPECIA AREATA CAUSED BY EMBOLIC DISLODGEMENT OF A GRAIN OF RADIOGOLD AFTER INSERTION INTO THE NECK REGION. Breuninger, H.; Feine, U. (Hals-Nasen-Ohrenklinik, Tuebingen, Ger.). Z. Laryngol., Rhinol., Otol., 47: 469-71(June 1968). (In German).

Development of alopecia areata following implantation in the trachea of 4 ^{198}Au seeds that each contained 10 mCi was reported. The patient's hair fell out within a 3-cm dia area on the right side of the head, where one of the ^{198}Au seeds was found and located by x ray. The hair began to grow back in the affected area after 8 weeks. Within 6 months the area appeared normal, but the seed could still be palpated. It was concluded that the ^{198}Au seed was transferred from the neck by way of the common carotid and superficial temporal artery to the scalp. The calculated dose from the ^{198}Au seed was ~2140 Rad. This far exceeded the 500 R calculated for an epilation dose. There was no evidence of erythema, skin damage, or bone changes in the area of the head irradiated by the ^{198}Au seed. (BBB)

31980 FURTHER STUDIES OF LATE LESIONS FOLLOWING DERMATOLOGIC RADIOTHERAPY. Kopp, H.; Reymann, F. (Finsen Inst., Copenhagen). Z. Haut- Geschlechtskr., 42: 349-54(May 15, 1967). (In German).

Incidence of late irradiation injuries observed in patients treated for plantar warts 20 yr previously with either 5 mg of Ra for 2¼ hr or 10 mg for 1 to 1¼ hr, Th X in alcoholic solution painted on the skin 2 or 3 times at intervals of 2 min, or Ra needles embedded in 2-mm thick wax plates was studied. The irradiation intensity contained in the plates varied from 0.02 to 0.1 mCi/cm^2, and the dose administered was from 0.5 to 0.9 mCi/cm^2. There were scars in 31.7% of the patients given a single Ra treatment and scars were found in 87.5% of those who had received two Ra treatments. The incidences of subjective complaints in these two groups were 7.7 and 85.7%. No ulcerations or malignant tumors were found. There were no signs of any irradiation injuries in the patients who had been treated with Th X or Ra emanations from the needles used in the wax plates. (BBB)

31981 RADIOLOGISTS, MEDICAL RADIATION, AND THE PUBLIC HEALTH. Saenger, Eugene L. (Univ. of Cincinnati). Radiology, 92: 685-99(Mar. 1969).

For diagnostic radiology and nuclear medicine, providing there is adequate gonad-shielding and minimization of fetal irradiation, current practices with good techniques need not be limited. Any further decrease in permissible radiation limits must derive from demonstration of effects in human beings at low doses. Further studies of radiation effects on the human fetus are needed. More studies evaluating the benefits of diagnostic radiation are required. Radiologists must continue and expand their efforts in support of research and research training for the further growth of this science. (auth)

31982 RADIATION EFFECTS AND CARCINOGENESIS. Morczek, A.; Schmidt, W. (Medizinische Akademie, Magdeburg, Ger.). Z. Gesam. Hyg. Ihre Grenzgeb., 13: 104-9(Feb. 1967). (In German).

In spite of the many publications on radiation-induced neoplasias the development of cancer and leukemia following radiation exposure must be regarded as a rare event. In the early days of medical application of radiation, excessive local radiation dosages caused tissue injuries leading to cancer. Insufficient protection against increased radiation dosages led to the frequent occurrence of radioinduced leukemias in radiologists. Today, experts in radiation-biological research endeavor to fix a limit dose under which the danger is considered negligible as compared to other risks of life, and in relation to the benefit of using radiation. (C.O.)

31983 CONTRIBUTIONS TO OSTEORADIONECROSIS. Lelek, L.; Altorjay, I. (Medical Univ., Szeged, Hungary). Radiol. Aust., 17: 67-74(1967). (In German).

Osteoradionecrosis as an early or late complication of radiotherapy is discussed. The symptoms and characteristics of osteoradionecrosis of the mandible, alveolar process, and hip joint; the doses of radiation which range from 6000 to 15000 R, and fractionation of irradiation are discussed. In the bone tissue, periosteum, and blood vessels, radiation causes progressive irreversible changes which are proportional to time. These changes are the basis for the early or late radiation necrosis. Besides the radiation, trauma and infection also have important roles. A late radiation necrosis of the bone has symptoms similar to an aseptic necrosis. The radiation-damaged bone tissue shows less resistance. Walking and more vigorous use bring micro or macro traumatas to the femoral neck. During walking four to five times the body weight is supported by the femoral neck. Pathological fractures of the femoral neck after late radiation necrosis are reported. The total doses and the different latent intervals indicate that it is very likely that the load on the hip joint has an important role in development of the late necrosis or fracture. The total dose given is of great importance for the regeneration of the bone and the healing of the fracture. A case of early radiation necrosis of a vertebral body is reported. This was caused by a 10 × 15 cm sized field with large fractional doses and high total dose (15 times 400 R). Soft tissue inflammation was marked. (BBB)

31984 LATE EFFECTS OF THOROTRAST IN MAN. Reiner, M.; de Siebenthal, J. (Hopital Cantonal, Geneva). Helv. Med. Acta, 34: 351-64(1968).

Pathogenic effects of ThO_2 deposition in man are reviewed and exemplified by reference to five cases in which Thorotrast had been used as a contrast agent. Thorium-232 mainly emits α particles, which, because of their weak penetrating properties, are mostly confined to the colloidal particle. However, even when only an estimated 1% of the α particles reaches the surrounding tissues, the resulting radiation in 1 yr by 1 g of Th amounts to 900 R. The β and γ rays from the breakdown products of Th may also contribute radiation injury. The use of Thorotrast in radiodiagnostic procedures may eventually lead to serious complications. If deposited in tissues, it presents a permanent source of irradiation responsible for local tumor development. Various malignant tumors induced by thorotrastosis are now becoming more frequently reported. Two cases of renal thorotrastosis are described resulting in squamous cell carcinoma of the renal pelvis that developed 24 and 27 yr after ascending pyelography. In a third patient a prophylactic nephrectomy was indicated because of unilateral renal thorotrastosis. In another patient, ascending pyelography with Thorotrast may have accounted for the late development of thrombocytopenia. In a 5th patient with generalized thorotrastosis following an arteriography, cirrhosis of the liver and liver cell carcinoma were found 21 yr postinjection. (BBB)

31985 RADIATION INJURY OF THE SKELETON FOLLOWING X-RAY THERAPY. Konstantinov, D.; Marowski, T. (Advanced Medical Inst., Plovdiv, Bulgaria). Folia Med. (Plovdiv)., 9: 298-303(1967). (In German).

Characteristics of irradiation injuries of the skeleton were reported. Clinical symptoms included pain, osteoporosis, and periosteosis. X irradiation of the nasopharynx with 6000 and 4000 R at an interval of 7 months caused a fistula of the cheek and extensive osteoporosis of the bone structure after 2 yr with disintegration and osteonecroses. This was accompanied by osteoporosis of the spongiosa of the hard palate and atrophy of the alveolar process of the upper jaw. Extensive bone damage of the chest cage with multiple spontaneous fractures, osteoporosis, and bone fusions were observed in a patient x irradiated for breast carcinoma. The major symptom of irradiation fractures of the neck of the femur was pain, which appeared long before a fracture was detected. Transverse fractures were observed frequently. The fractures did not heal, and the broken ends of bone became gradually flattened. Atrophic bone changes were observed in patients irradiated with extensive series of x ray treatments in the pelvic region. In general, osteoporosis produced by x irradiation was diffuse, and depending on the severity of irradiation damage, the bone damage produced tended to become stabilized. (BBB)

31986 UNUSUAL CHROMOSOMAL FINDINGS IN A CASE OF MYELOFIBROSIS. Goodman, Richard M.; Bouroncle, Bertha A.; Miller, Frances; North, Carol (Univ. Hospital Columbus, Ohio). J. Hered., 59: 348-50(Nov.-Dec. 1968).

Observations are reported on a ring chromosome appearing in conjunction with a small group-F chromosome in a patient who had myelofibrosis secondary to polycythemia vera treated with ^{32}P. This cytogenetic combination has not been described previously in this disorder. The possible role of ^{32}P irradiation is considered. The patient, a 79-yr-old woman, was diagnosed 9 yr previously as having classical polycythemia rubra vera and was treated from 1958 to 1963 with a total dose of 17.5 mCi of radiophosphorous and phlebotomies. In 1967, a diagnosis of anemia secondary to myelofibrosis was made and confirmed by bone marrow biopsy. The patient was started on a course of myleran therapy. At postmortem examination, findings compati-

ble with a myeloproliferative syndrome were confirmed. The predominant cytogenetic aberration seen was the presence of a ring chromosome in conjunction with a small group-F chromosome. The presence of a ring chromosome in the C group indicates that 2 breaks had occurred and the 2 ends of the chromosome had united to form this aberration. There is no evidence that either of these fragments had become translocated. Since certain drugs including radiophosphorous and myleran may produce chromosomal aberrations, it was difficult to establish a definite relation between the patient's disease and the cytogenetic findings described. Yet others have described apparent deletion of an F-group chromosome observed in the bone-marrow cells in 7 patients with polycythemia vera. Six of these patients had received radiophosphorous prior to the time of their observations. In general, ring chromosomes in man tend to appear in pathological states, including after irradiation. Further cytogenetic and metabolic studies on patients with polycythemia vera, myelofibrosis and other myeloproliferate disorders must be made to answer some of the questions raised by this and previous reports. (BBB)

31987 EFFECTS OF RADIATION ON TEETH. Poyton, H. G. (Univ. of Toronto). Oral Surg., Oral Med., Oral Pathol., 26: 639-46(Nov. 1968).

The pathological effects of therapeutic doses of x radiation of 4,000 to 6,000 rads on developing and formed teeth are reviewed. It is concluded that developing teeth are more radiosensitive than formed teeth and the extent of injury depends on the radiation dose and stage of development at the time of exposure. The pathological effects of laser radiation on human teeth are also discussed briefly. (C.H.)

31988 GASTRO-INTESTINAL FUNCTION AFTER ABDOMINAL COBALT IRRADIATION. Ratzkowski, E.; Hochman, A. (Hadassah Univ. Hospital, Jerusalem). Acta Radiol., Ther., Phys., Biol., 7: 417-32(Dec. 1968).

Therapeutic telecobalt irradiation with 2,000 to 4,000 rad was administered in 75 patients with generalized abdominal malignancy. The effect upon the intestinal mucosa, as indicated by the B_{12} absorption, triolein absorption, PVP, and gastric acid secretion tests, is discussed. (auth)

31989 HEMATOLOGICAL CHANGES IN PROFESSIONALLY EXPOSED PERSONS IN RELATION TO DOSE VALUES. zur Horst-Meyer, Horst (Univ., Berlin). Strahlentherapie, 137: 315-19(Mar. 1969). (In German).

Hematological changes in persons professionally exposed to radiation are studied. An increase of hemoglobin and an increase in the cellular volume determined by dose rate are observed. The increase of corpuscular volume becomes less important when the exposure dose increases. The observed modifications can be explained, in analogy with pernicious anemia, by considering induced disorders of DNA metabolism. (tr-auth)

31990 STUDIES ON THE INFLUENCE OF IONIZING RADIATION ON ERYTHROCYTES. PART I. LITERATURE REVIEW, CHARACTERISTIC MATERIAL, AND METHODS OF STUDY. Gerhardt, Paul (Univ., Tuebingen, Ger.). Strahlentherapie, 137: 300-14(Mar. 1969). (In German).

Radiation effects on erythropoiesis in animals and man are studied. An extensive review of the literature is presented; 261 references are given. (H.B.G.)

Radiation Effects on Plants

Refer also to abstracts 31662, 31686, 31687, 31689, 31691, 31694–31698, 31703, 31707, 31708, 31819, 31878, 31902, 31950, and 32008.

31991 THE EFFECTS OF X-IRRADIATION ON STOLON GROWTH AND HYDRANTH PRODUCTION IN CAMPANULARIA FLEXUOSA: GLUTATHIONE AS A RADIOPROTECTIVE AGENT. Wermuth, Jerome Francis. Bloomington, Ind., Indiana Univ., 1968. 81p.

Thesis.

X-ray doses of 81,000 R were delivered to various parts of five-day-old colonies of the hydroid Campanularia flexuosa. The average daily values of stolon length and hydranth production by new stolons of starter-irradiated colonies, new stolon irradiated colonies, and wholly irradiated colonies were compared to the same values for control colonies. The average daily values of stolon length of starter-irradiated colonies were significantly greater post-irradiation than the same values in control colonies. The average daily values of stolon length of wholly irradiated colonies were significantly greater than the same values for stolon-irradiated colonies for the first three days after irradiation. Stolons of both these groups then stopped growing and died. Hydranth production by new stolons of starter-irradiated colonies seemed to be delayed when compared with hydranth production by control colonies. This phenomenon was not consistently reproducible. Average daily values of stolon length and hydranth production by new stolons of starter-irradiated colonies were not significantly different post-irradiation from the same values of control when both sets of colonies were incubated in a freshly prepared 10^{-5} M reduced glutathione-sea water solution for 24 hrs prior to irradiation. The average daily values of stolon length and hydranth production by new stolons of wholly irradiated colonies were not significantly different post-irradiation from stolon-irradiated colonies under the same conditions of incubation in glutathione-sea water. Irradiated stolons, even though incubated, stopped growing after three days and died. In another series of experiments, average daily values for stolon length and hydranth production by starters of starter-irradiated colonies were compared to the same values for nonirradiated colonies when both sets of colonies were variously incubated in 10^{-5} M reduced glutathione-sea water solutions. Hydranth production by starters of starter-irradiated colonies was severely curtailed by the irradiation in all groups. X irradiation did not interfere with the development of hydranths that had reached an early, but morphologically recognizable developmental stage. Hydranth positions that had regressed at the time of irradiation were unable to regenerate new hydranths. Hydranth positions that regressed after irradiation were unable to regenerate new hydranths. The results indicate that starters are the source of a stolon-growth inhibitor. X irradiation of starters represses the activity of the stolon-growth inhibitor system. Under certain conditions of incubation in a 10^{-5} M reduced glutathione-sea water solution, the stolon-growth inhibitor system is protected from irradiation damage. Incubation of colonies does not protect hydranth positions and new stolons from irradiation damage. (Disser. Abstr.) (TSS)

31992 TUMOR INDUCTION BY HEAVY IONIZING PARTICLES AND X-RAYS IN ARABIDOPSIS. Hirono, Y.; Smith, H. H.; Lyman, J. T. (Brookhaven National Lab., Upton, N. Y. Univ. of California, Berkeley). Radiat. Bot., 8: 449-56(Dec. 1968).

Irradiation of seeds with x rays and with several accelerated heavy ions induced tumors in Arabidopsis plants. The type of tumor was macroscopically the same for each type of radiation. The dissimilarities in location and growth of tumors caused by x rays vs heavy ions were attributed to differences in depth-dose distribution. The heavy ionizing particle beams were adjusted so that the Bragg peak fell in the stem meristematic region of the seed embryo. (auth) (UK)

31993 EFFECT OF THE γ-IRRADIATION ON THE DEVELOPMENT OF PENICILLIUM DIGITATUM ROT ON INOCULATED CITRUS FRUIT IN COMPARISON WITH THE EFFECT OF DIPHENYL. Barkai-Golan, Rivka. Ktavim, 115-18(Aug. 1967). (In Hebrew).

The percentage of rotten fruit was measured as a function of time during the first 36 days after infection with Penicillium digitatum. The fruits were exposed to 50, 100, 150 and 200 krad of γ radiation from a ^{60}Co source. A direct correlation was found to exist between the irradiation dose and the incubation period of P. digitatum. Exposure to 150 krad delayed the incubation by 3 weeks while treatment with the usual diphenyl paper (30 mg per sheet) delayed the rot by 8 to 9 days. Further increase of the γ radiation dose caused considerable damage to the citrus fruit. (TTT)

31994 EFFECTS OF SIMULATED RADIOACTIVE FALLOUT DECAY ON GROWTH AND YIELD OF CABBAGE, MAIZE, PEAS, AND RADISH. Sparrow, A. H.; Puglielli, Leanne (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 9: 77-92(Mar. 1969).

An apparatus designed to simulate the decay of radioactive fallout from nuclear detonations is briefly described and data are reported from experiments undertaken to determine the relative effectiveness of similar total exposures of ^{137}Cs gamma radiation given at uniform exposure rates vs. simulated fallout decay. Seedlings of pea, maize, cabbage and radish were given three different treatments (16-hr and 36-hr uniform dose-rate exposures, and a 36-hr simulated fallout decay exposure with changing dose rates). Seedlings were exposed to the ^{137}Cs γ-radiation and transplanted to the field (maize and cabbage) or moved to a greenhouse for observation (radish and pea). Data on plant survival, gross vegetative growth, crop yield and pollen abortion are reported from scorings made weekly for up to about three months. Comparisons were made among the three radiation treatments for survival end points (LD_{10}, LD_{50}, LD_{90}, and LD_{100}) and the 50 per cent reduction in fresh weight and crop yield. In all experiments the simulated fallout decay gamma exposure produced more deleterious effects than an equivalent total exposure

delivered at uniform rates, and the 16-hr exposure produced more severe effects than similar exposure delivered in 36 hr. When the results of 36-hr uniform exposures were compared to those from the 36-hr simulated fallout decay, the average increase in effectiveness varied from a factor of 1.79 to a factor of 2.04, with the average for all end points being 1.93 (almost a factor of 2 greater). Exposures which gave reductions of 50 per cent in fresh weight and crop yield for the same two radiation treatments varied by a factor of 1.59 to a factor of 2.11, with an average increase in effectiveness for all end points of 1.80 for the simulated fallout exposures. Predicted LD_{50}s for 16-hr uniform and 36-hr FDS exposures based on measured interphase chromosome volumes are given for 49 varieties of economic plants. (auth)

31995 RECOVERY FROM GAMMA RADIATION INJURY IN BARLEY SEEDS. Joshi, R. K.; Gaur, B. K.; Notani, N. K. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Bot., 9: 141-5(Mar. 1969).

Studies were carried out to determine the relationship and significance of seed moisture content during irradiation and postirradiation storage periods to radiation injury. Barley seeds were equilibrated in atmospheres of known humidity to obtain dry, moist, and wet seeds having about 3.5, 8.5, and 16.5 per cent water, respectively. These seeds were exposed to ^{60}Co γ-rays (dose rate 2.4 krads/min) so as to cause ~50 per cent radiation induced injury in unstored irradiated seeds. The seeds, after irradiation, were stored in various humidity atmospheres before hydration and sowing. Little modification of radiation injury occurred if the water-status of seeds during irradiation was either maintained or lowered during the post-irradiation storage period. A very conspicuous recovery was obtained by raising the water content of seeds during storage; a change from dry to wet was more effective than that from dry to moist or moist to wet. (auth)(UK)

Radiation Effects on Microorganisms

Refer also to abstracts 31647, 31648, 31656, 31685, 31688, 31690, 31705, 31706, 31902, and 31950.

31996 INFECTIVITY AND CAPACITY FOR DNA REPLICATION OF VACCINIA VIRUS IRRADIATED BY γ RAYS. Decker, C.; Guir, J.; Kirn, A. (Institut de Bacteriologie, Strasbourg). J. Gen. Virol., 4: 221-7(Mar. 1969).

The action of γ rays was studied on vaccinia virus infectivity and on the DNA replication capacity of the virus. To protect the virus against indirect irradiation effects, the chemical protection provided by a high concentration of an inert organic substance (10% calf serum) was combined with the physical protection of the solid state that greatly reduces the migration of free radicals (−70°). In this case the indirect effects of radiations were shown to be negligible. The virus suspensions were exposed to radiation doses of 3×10^4 to 1.5×10^6 R at a rate of 600 R/min from a ^{60}Co source. The ability of the irradiated samples to form plaques (infectivity) and to induce viral DNA synthesis was determined. The radiosensitive volume of the viral unit causing infection (1.9×10^{-17} cm^3) was very small compared with the volume of the whole viral DNA (about 10%). The inactivation of the DNA replication function followed a simple exponential law. The radiosensitive volume necessary for the replication of DNA (1.6×10^{-18} cm^3) represents only 8.5% of the DNA necessary for infectivity and 0.85% of the total viral DNA. This indicates existence of a dissociation between two functions of vaccinia virus, the synthesis of viral DNA and infectivity. (BBB)

31997 POSSIBLE EXPLANATION FOR THE METABOLIC RADIOPROTECTIVE EFFECT OF CYSTEINE ON ESCHERICHIA COLI B. Kovacs, P.; Kari, Cs.; Nagy, Zs.; Hernadi, F. (Univ. Medical School, Debrecen). Radiat. Res., 36: 217-24(1968).

The growth of logarithmic-phase cultures of E. coli B cells on glucose-mineral medium was partially inhibited by 0.2 mM L-cysteine-HCl. Twenty other amino acids failed to show a similar inhibiting effect even at a concentration of 10 mM. After incubation of the log-phase culture in the presence of 2.0 mM cysteine for 30 minutes (inhibition about 70%) the cells were centrifuged, resuspended, and diluted 200-fold in cysteine-free phosphate buffer. These cells exhibited increased resistance to the effect of x rays as measured by the number of colony-forming units. Both the growth-inhibiting and the radioprotective effects of cysteine could be diminished by the presence of 0.5 mg of casein hydrolyzate per milliliter during the 30-minute preirradiation culture period. This "anti-cysteine" effect was caused mainly by L-leucine, L-isoleucine, L-valine, and L-threonine from among the amino acids of casein hydrolyzate. It is suggested that cysteine inhibits the biosynthesis of some amino acids, thereby blocking protein synthesis, which may result in increased radioresistance. (auth)

31998 MODIFIED EFFECT OF INORGANIC SALTS ON THE SENSITIVITY OF ASPERGILLUS NIGER ^{35}V TO ULTRAVIOLET RAYS. Mazumder, Malati; Mishra, A. K.; Nandi, P. (Bose Inst., Calcutta). Sci. Cult. (Calcutta), 34: 309-11(July 1968).

Spore suspensions of Aspergillus niger were prepared and subjected to ultraviolet radiation. They were placed in solutions of inorganic salts before, after, and during irradiation. Inorganic salts used were KCl, KH_2PO_4, KNO_3, $MgSO_4$, NaCl, $NaNO_3$, NH_4NO_3. After treatment, the spores were plated on agar, incubated, and the colonies were counted. When the spores were treated before irradiation, survival increased with KNO_3, NaCl, $MgSO_4$, KH_2PO_4, and decreased with $NaNO_3$, KCl, and NH_4NO_3. When treated during irradiation, survival was increased by KNO_3, NaCl, and KH_2PO_4, and decreased by $NaNO_3$, NH_4NO_3, KCl, and $MgSO_4$. When treated following irradiation, survival decreased with all chemicals except NaCl and KNO_3. (H.L.W.)

31999 EFFECTS ON THE INFECTIVITY OF IONIZING RADIATION ON WHOLE BLOOD INFECTED WITH ANAPLASMA MARGINALE. Castro, Edin Raul; Canabez, Freddie (Univ., Montevideo). Bol. Chil. Parasitol., 23: 23-6(Jan.-June 1968). (In Spanish).

Studies were conducted on the effects of ^{60}Co γ radiation on infectivity of whole blood infected with A. marginale in ten splenectomized and three normal cattle. The blood received doses varying from 1250 to 100,000 R. After injection of the infected irradiated blood in cattle, their hematologic parameters and the incidence of infection were evaluated. The results showed that even the highest dose did not destroy infectivity of the blood, all of the inoculated cattle dying except those treated with tetracycline. Anaplasma organisms were detected in blood smears stained by the Geimsa technique. The conflict between these results and those of Simpson, et al. is attributed to the different methods of blood processing whereby damage to the erythrocytes enhanced A. marginale. (BBB)

32000 ANTIMICROBIAL AGENTS AND CHEMOTHERAPY: 1967. Proceedings of the Seventh Interscience Conference, Chicago, Ill., 25-27 October 1967. Hobby, Gladys L. (ed.). Ann Arbor, Mich., American Society for Microbiology, 1968. 790p. $15.00. (CONF-671067). Williams and Wilkins Co., Baltimore $15.00.

One hundred and twenty eight papers are included in these proceedings. The papers are divided into eleven sections as follows: introduction (1), the regulation of clinical investigation (7), infectious diseases: experimental and clinical studies (24), optimal duration of antibiotic therapy in severe bacterial infections (5), antibiotic synergism and antagonism (5), the mode of action of antimicrobial agents (6), relation of chemical structure to mechanism of antibiotic action (3), new antibiotics and the chemistry of antibiotics (24), synthetic antimicrobial agent (13), new penicillins and cephalosporins (16), in vitro and in vivo antimicrobial effects (17), and the pharmacological properties of antimicrobial agents (7). Separate abstracts were prepared in two of these papers. (E.R.B.)

For abstracts of individual papers see: 31668 and 31690.

32001 "EXCISION REPAIR" AND DOSE-MODIFICATION: QUESTIONS RAISED BY RADIOBIOLOGICAL EXPERIMENTS WITH ACRIFLAVINE. Alper, Tikvah; Hodgkins, Brenda (Hammersmith Hospital, London). Mutat. Res., 8: 15-23(July–Aug., 1969).

If bacteria are in contact with acriflavine before exposure to uv irradiation, they are strongly protected. With Escherichia coli B and six resistant and sensitive mutants, 30-min contact with acriflavine at 5 μg/ml confers protection that is strictly dose-modifying, and is the same for all variants, viz. dose-reduction factors of 10 and 15 for aerobic and anoxic conditions respectively. There is good chemical evidence for interpreting the protection as stemming from intercalation of the dye molecules between bases which are consequently inhibited from photochemical interaction between neighbors. Strict dose-modification is seen also when effects of uv are modified by enzymatic photoreactivation, which is known to monomerize pyrimidine dimers. Dose-modification is to be expected if an agent or procedure changes the probability that a given photochemical event will occur, or that it will remain in lethal form. It should also be expected, therefore, if a photochemical product is "excised" from DNA. However, excision-repair, which has been widely postulated to account for differences in sensitivity between variants of a strain, or for modification of uv damage, fails to act as a dose-modifying agent. Some of this failure has been attributed to the inactivation of the postulated repair enzymes by the radiation, but evidence from our experiments shows that

this explanation is unlikely. Further experiments in which the lethal effects of uv were enhanced by the presence of acriflavine in the growth medium after irradiation throw doubt on the assumption that in this role acriflavine acts by inhibiting "excision repair". (auth)

32002 LETHAL AND MUTAGENIC EFFECTS OF IRRADIATED MEDIUM ON ESCHERICHIA COLI. Chopra, V. L. (Inst. of Animal Genetics, Edinburgh). Mutat. Res., 8: 25-33(July-Aug. 1969).

X- and γ-irradiated synthetic minimal medium was found to have a strong lethal effect on E. coli incubated in it. The lethal effect of γ-irradiated medium increased when the dose to the medium was increased from 50 to 500 krad. The production of cytotoxic principle was found to be dose-rate dependent, and its effect was inversely related to the number of bacteria per ml seeded into the irradiated medium. The lethal effect was found to arise from irradiation of the glucose component of the medium. The observations that the lethal effect of irradiated medium could be duplicated by adding amounts of hydrogen peroxides that will be obtained in the medium by irradiation and that catalase completely negated the effect of irradiated medium suggest that peroxides constitute the cytotoxic principle. Treatment with irradiated medium was found to enhance significantly the mutation rates for both forward and reverse mutations. (auth)

32003 HOST-CELL REACTIVATION OF GAMMA-IRRADIATED PHAGE T1 IN STRAINS OF ESCHERICHIA COLI K-12. Meyn, Raymond; Friensen, Benjamin; Baptist, Jeremy (Univ. of Kansas, Lawrence). Contract AT(11-1)-1686. Mol. Gen. Genet., 104: 66-72(1969). (COO-1686-6).

Host-cell reactivation of γ-irradiated phage T1 in strains of Escherichia coli K-12 was compared with HCR of uv-irradiated phage in these same strains and with the radiation sensitivities of these strains. The pattern of the HCR of γ-irradiated phage in these strains was like that of the HCR of uv-irradiated phage. HCR in strains whose genotype was uvr^+ rec^- was like that of the wild type; whereas, HCR was minimal in strains that were uvr^-. It is suggested that some type of γ-radioinduced base damage in phage DNA is repaired in uvr^+ strains. (auth)

32004 COMPLEMENTATION BETWEEN EXR AND UVR A STRAINS OF ESCHERICHIA COLI. Chung, Young S.; Greenberg, Joseph (Palo Alto Medical Research Foundation, Calif.). Mol. Gen. Genet., 104: 12-15(1969).

When P1 phages grown on strain Bs12 (HCR) were used to infect exr strains Bs 2, 4, and 7, and the reverse, a significant increase in survivors of uv radiation was observed over those found in selfing experiments. No such increase in survivors was found when P1 grown on each of the exr strains was used to infect each of the other exr strains. Only 1% of the survivors of uv radiation were stably resistant to uv radiation. These data are considered a demonstration of complementation between the mal B-linked, uv radiosensitivity genes of Bs12 (uvrA) and Bs2, 4, and 7 (exr). (auth)

32005 INDUCTION OF DNA BREAKDOWN AND DEATH IN ESCHERICHIA COLI BY PHLEOMYCIN. ITS ASSOCIATION WITH DARK-REPAIR PROCESSES. Grigg, G. W. (Commonwealth Scientific and Industrial Research Organization, Epping, New South Wales). Mol. Gen. Genet., 104: 1-11(1969).

Phleomycin, at concentrations above 1 μg/ml, induced breakdown of DNA and death in Escherichia coli. Exponentially growing cultures were 10 times more sensitive to phleomycin than were stationary cultures, and the effect was somewhat dependent on the medium. Excisionless (HCR) mutants of E. coli were insensitive to doses of phleomycin that killed over 99% of wild-type organisms within one hr, while EXR mutants were considerably more sensitive. Mutants of E. coli selected for phleomycin resistance were unable to reactivate uv-irradiated T1 phage (HCR). It was concluded that the DNA breakdown, inhibition of DNA replication, and cell death were a consequence of initial attack by an excision-endonuclease stimulated by the phleomycin. (auth)

Radiosterilization and Radiopreservation

32006 (NP-17878) CONTRIBUTION TO THE STUDY OF THE EFFECT OF THE IRRADIATION ON 4 VITAMINS OF GROUP B AND VITAMIN C. Chacun, Jean-Pierre (Paris Univ. (France). Faculte de Medecine). 1967. 69p. (In French). Dep.

Thesis.

A review of the mechanisms of ionizing radiations including elementary physico-chemical phenomena is presented. Some examples of the uses of irradiation in nutrition, such as radiosterilization of grain, are described. Effects of radiation on proteins, lipids, carbohydrates, and vitamins are discussed; a table is presented to show effects of heat, oxygen, light, and ionizing radiation on vitamins. Undesirable effects of radiation on organoleptic properties of foods are discussed. Experiments were conducted on the effects of radiation on vitamins B1, B2, B6, PP, and C in yeast, cream of rice, potatoes, and carrots. It was found that in yeast vitamins were more radiosensitive in suspension than in the dry product. Vitamins B1 and PP of yeast were destroyed by radiation, while B2 and B6 were resistant to radiation. In cream of rice, vitamin B1 was destroyed by radiation, while B6 and PP were radioresistant. Vitamin C was destroyed by radiation in carrots and potatoes. (H.L.W.)

32007 INVESTIGATION OF PASTEURIZATION AND STERILIZATION OF MEAT BY MEANS OF IONIZING RADIATION. Preininger, Vladimir. Prum. Potravin, 14: 49-54(1963). (In Czech).

Radiation preservation of whole and cut-up beef and pork was studied in five experiments with the radiation from a nuclear reactor and 11 with that from a 5000-Ci ^{60}Co source. Pasteurizing doses up to 1,000,000 reps did not allow storage at room temperature; for sterilization, 1,200,000 to 2,100,000 reps was required. Gamma, neutron, and α irradiation resulted in organoleptic changes, but the γ rays were more efficient agents than the other types. In the irradiation process, H_2S, methyl mercaptan, and other materials developed in the meat and adversely affected the odor, taste, and color. Lysine, glutathione, glycogen, thiamin, vitamin B_1, and other valuable components decreased, while aspartic and glutamic acids and alanine increased. Both tin and polyethylene were used in the tests for packaging; meat packaged in polyethylene losts its color. The irradiated product was better when 0.1 to 0.5% ascorbic acid was added. Flavin had unfavorable effects. The changes that occurred depended on various factors, e.g., fat content, age of the meat, dose rate, type of radiation, and temperature at which the irradiation was carried out. (TTT)

32008 HEAT SENSITIZATION OF CONTROL OF GREY MOLD OF STRAWBERRY FRUITS BY GAMMA IRRADIATION. Sommer, N. F.; Buckley, Patricia M.; Fortlage, R. J.; Coon, D. A.; Maxie, E. C.; Mitchell, F. G. (Univ. of California, Davis). Radiat. Bot., 8: 441-8(Dec. 1968).

Control of the postharvest grey mold disease (Botrytis cinerea) of strawberry fruits by gamma irradiation is improved by prior heat sensitization. The resulting synergistic interaction between heat and radiation achieves a level of fungus inactivation that could not be obtained, without excessive fruit injury, by either treatment alone. Even heat treatments designed only for sensitizing the fungus, not inactivation, must provide precise control of time and temperature to avoid fruit injury. It was demonstrated that heating sensitizes B. cinerea to irradiation more than irradiation sensitizes to heating. A partial desensitization of the fungus was associated with delays between heating and irradiation. (auth) (UK)

32009 THE EFFECT OF DECONTAMINATION OF FEED MIXTURES BY HEAT TREATMENT AND GAMMA-RADIATION ON GROWTH AND FEED CONVERSION OF FATTENING PIGS. Dammers, J. (Instituut voor Veevoedingsonderzoek, Hoorn, Netherlands); Kampelmacher, E. H.; Edel, W.; Van Schothorst, M. Landbouwk. Tijdschr., 79: No. 4, 106-9(Apr. 1967). (In Dutch).

Two experiments were carried out with fattening pigs in an attempt to establish whether total decontamination of a feed mixture affected its nutritional value. All animals received the same feed, which was given either untreated (control), after heat treatment (one group) or after decontamination by γ irradiation (^{60}Co) (another group). In view of the possible inactivation of vitamins during decontamination, a complete vitamin mixture was added to the feed immediately before feeding. The methods of decontamination tested ensured adequate elimination of Salmonellae and showed no detrimental effect on the nutritional value of the feed mixture. (auth)

32010 PRESENT STATUS OF STUDIES ON IRRADIATED FOODS. Fujimaki, Masao (Tokyo Univ.). Shokuhin Eiseigaku Zasshi, 9: 337-47(Oct. 1968). (In Japanese).

Food irradiations are now in the stage of actual utilization and the problem of legal approval of such irradiations is nearly settled. In Japan the basic studies were initiated about ten years ago and in 1968 the national program of such studies was decided, including the irradiation effect and the safety and wholesomeness of irradiated foods (potatoes, onions, etc.). The present state of food irradiations is described in the following: the purposes of food irradiation and foods for irradiation; changes induced by irradiation of foods (potatoes, onions, sausages); wholesomeness of the irradiated foods; wholesomeness tests of irradiated onions and highly irradiated wheat flour; the wholesomeness of ham in relation to the dis-

approval in the United States of the application for irradiation of this product. (NSA of Japan) (auth)

32011 IRRADIATION OF PACIFIC COAST FISH AND SHELLFISH. 7. STORAGE LIFE AT 33°F. OF IRRADIATED AND REPACKED MEAT OF DUNGENESS CRAB. Teeny, F. M.; Miyauchi, D.; Pelroy, G. (Bureau of Commercial Fisheries Tech. Lab., Seattle). Fish. Ind. Res., 5: 17-24(May 1969).

Fresh Dungeness crab meat, owing to its relatively short and variable shelf life, is ordinarily restricted to sale close to its area of production. To find a basis for widening the area of sale, the shelf life for Dungeness crab meat irradiated in wholesale containers, stored 12 or 20 days at 33°F, and subsequently repacked into retail containers and again stored at 33°F was determined. The repacked samples had adequate shelf life for marketing in retail stores. Thus, irradiation of Dungeness crab meat in wholesale containers would permit this product to be widely distributed in retail stores. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

32012 (BNL–50163) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 6, Number 6. (Brookhaven National Lab., Upton, N. Y.). June 1968. 52p. Dep. CFSTI.

Sixteen abstracts of recent reports on reactor development and the technology of high temperature liquid metals are included containing information on the thermodynamic and transport properties of alkali metals, fission product behavior in Na, safety aspects of Na cooled reactors, effect of Na on the mechanical properties of cladding and structural materials, Na chemistry, corrosion behavior in Na, power train design for K test turbine, boiling K Rankine cycle system, liquid metal MHD power conversion, and liquid metal bearings. (F.S.)

Corrosion and Erosion

32013 (MSAR–69–42) THE EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, October–December 1968. (MSA Research Corp., Evans City, Pa.). Apr. 1969. Contract AT(11-1)-765. 158p. Dep. CFSTI.

Loops are used in testing the effects of high temperature sodium on the mechanical properties of candidate alloys for the LMFBR program. Creep-rupture testing of specimens exposed at 1200°F and 1400°F in Loop 2 high-oxygen sodium and helium excursion was continued. Creep-rupture testing of Type 304 stainless steel was initiated. Results of long-term exposures of Types 304 and 316 stainless steels in 1200°F clean sodium in static retorts are given. Creep-rupture results of six candidate ferritic alloys in clean sodium at 1200°F are given. The alloys include 2¼ Cr–1 Mo, 2¼ Cr–1 Mo–V, 2¼ Cr–1 Mo–Ti, 3 HK5S, Croloy, and Croloy–Ti. Specimens have been tensile tested in air at room temperature and at 1050°F. Vanstar 7 and Vanstar 8 were tested in Loops 1, 2, and 3. Tensile test results on IN-744 and USS 18-18-2 are given. Efforts directed toward development of a high temperature extensometer were continued. A carbon meter was evaluated and calibrated. (J.C.W.)

32014 (ORNL-tr–2153) OXIDATION OF TUNGSTEN AND RHENIUM AT LOW PRESSURE. Cassuto, Albert; Mihe, Jean-Pierre. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Compt. Rend., Ser. C, 266: 863-6(1968). 5p. Dep. CFSTI.

The surface oxidation rates of tungsten and rhenium were measured in a range of temperature between 1400 and 2500°K for oxygen pressures varying between 5.10^{-6} and 3.10^{-4} torr. The curves pass through a maximum which depends on the pressure, due to the production of atomic oxygen at high temperature (greater than 2000°K). These indicate the validity of the same type of equations which implies an analogous method of oxidation. (auth)

32015 (ORNL-tr–2154) FACTORS INVOLVED IN THE CORROSION UNDER STRAIN OF MATERIALS USED IN REACTORS. Tragert, W. E. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Corros. Anti-Corros., 8: 196-201 (1960). 19p. Dep. CFSTI.

An attempt has been made to explain the formation of fissures by corrosion under strain in metals and alloys in the light of certain hypotheses which have been proposed and which are classified into various concepts: electrochemical-mechanisms, electrochemical-mechanical concepts, fissuring by absorption of stresses. In the case of corrosion of uranium alloys, the contribution that these theories can make to the explanation of observed phenomena is discussed. (auth)

32016 (RD/B/N–1384) OXIDATION STUDIES ON IRON USING THE MOESSBAUER EFFECT. I. PRELIMINARY EXPERIMENTS. Channing, D. A.; Graham, M. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1969. 19p. Dep.

The potential of the Mössbauer effect for quantitative investigation of oxidation processes on iron is demonstrated. Different oxide phases formed simultaneously on thin foils in 1 atm of oxygen at 500°, 610° and 700°C were identified and analyzed using the technique. At 500° and 610°C Fe_3O_4 and α-Fe_2O_3 were observed; their relative amounts depended upon the thermal treatment. At the lower temperature the vacuum reduction by iron of α-Fe_2O_3 to Fe_3O_4 was followed, and conversely the growth of α-Fe_2O_3 from Fe_3O_4 in oxygen. After oxidation at 700°C FeO was additionally found. (auth) (UK)

32017 CONSIDERATIONS ON THE ATOMISTICS OF OXIDATION. Lightstone, J. B. (Harvard Univ., Cambridge, Mass. Kennecott Copper Corp., Lexington, Mass.); Pemsler, J. P. pp 461-74 of Kinetics of Reactions in Ionic Systems. Gray, T. J.; Frechette, V. D. (eds.). New York, Plenum Press, 1969.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y. See CONF-670625.

Experiments were performed to determine the effect of structure on the mechanism of zirconium oxidation. It is shown that there is a high volume fraction of short circuit diffusion paths in the oxide formed on Zr at 500 to 1000°C. The results of tracer experiments are in agreement with a short circuit diffusion mechanism. The assumption of line diffusion is shown to imply intuitively reasonable values of both the grain boundary thickness and the ratio of the line diffusion coefficient to the coefficient for lattice diffusion. (auth)

32018 ANODIC OXIDATION OF Ti–Zr ALLOYS IN THE REGION BELOW THE OXYGEN EVOLUTION POTENTIAL. Nakata, Koreaki; Iida, Yoshio (Matsushita Electric Industrial Co., Ltd., Osaka). Denki Kagaku, 37: 366-9(May 1969). (In Japanese).

Ti, Zr and Ti–Zr alloys were anodized at potentials below the oxygen evolution level. The results obtained are consistent with the equation; $i_+ = A \exp BE$ where i_+ is ionic current; E, field strength across the film and A and B are constants. The Ti–Zr alloy has a higher field strength for film growth at a given current density than the pure Ti and Zr. According to the Cabrella-Mott theory for very thin film growth, B is expressed by $q\lambda/kT$, where q is the charge of the metal ion and λ, the half-width of the potential energy barrier for metal ion migration. The λ value for the specimens increased with increasing Zr content. This is consistent with the trend toward a higher lattice constant α_0 with increasing Zr content of the oxide. (auth) (NSA of Japan)

32019 OXIDATION OF Be–Ca ALLOYS IN CO_2 AT HIGH TEMPERATURES. Nishigaki, Susumu (N. G. K. Insulator Co., Ltd., Nagoya, Japan); Kondo, Yasuko; Nagasaki, Ryukichi. Nippon Kinzoku Gakkaishi, 33: 455-60(1969). (In Japanese).

Three Be–Ca alloys with varied Ca contents were oxidized at temperatures between 600 and 700°C. A kinetic analysis of the rates of weight gains at different temperatures led to a conclusion that the oxidation proceeded through at least three stages. A close relation was noted between the mode of the oxide film growth and the oxidation behavior at each stage. Addition of a small amount of Ca improved markedly the corrosion-resistance of Be. The effect was explained in terms of the dispersion of the corrosion resistant $Be_{13}Ca$ phase, and the formation of a Ca-rich layer at the metal-oxide interface which plays a vital role as a barrier against Be-ion diffusion. (auth)

32020 THE OXIDATION OF ZIRCONIUM AT HIGH TEMPERATURES. THE OXIDATION KINETICS OF ZIRCONIUM POWDER IN O_2 AND CO_2 ATMOSPHERE. Cismaru, D.; Dobroghiu, Elisabeta (Inst. of Physical Chemistry, Bucharest). Rev. Roum. Chim., 14: 291-6(Mar. 1969).

Studies were carried out on the oxidation of Zr powder with O_2 from 125 to 175°C at atmospheric pressure and with CO_2 from 350 to 500°C at 0.368, 0.197, and 0.0986 atm. (auth)

Preparation and Fabrication

32021 (AECL–3227) PHYSICAL FEATURES IN THE INTERACTIONS OF POINT DEFECTS IN METALS WITH SPECIAL REFERENCE TO ZIRCONIUM. Piercy, G. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1968. 18p. Dep. CFSTI. CAN $0.50.

The physical arguments behind the present understanding of the interaction between different solute atoms and vacancies are described in a qualitative manner. Application of these to zirconium indicates that a rare-earth solute may have the large interaction with vacancies that could reduce the in-reactor creep rate by acting as a vacancy-interstitial recombination center, or improve the high temperature mechanical properties by forming a stable precipitate. (auth)

32022 (CEA-R–3675) DIFFUSION WELDING. Daniault, Joeel; Gillet, Rene (Commissariat a l'Energie Atomique, Gre-

noble (France). Centre d'Etudes Nucleaires). Mar. 1969. 44p. (In French). Dep.

Preliminary trials of metallic bonding using combinations such as Ta to Mo, Zr to Zr, Zr to Nb, Nb to stainless steel, Mo to stainless steel, and Al to Al are described. Trials involving bonding of tubular elements made of Mo or Nb to stainless steel are also described and comment concerning the bond tightness and resistance to thermal cycling damage in these bonds is included. A method for fabrication of radiation windows in Be welded on stainless steel elements is discussed. (J.R.D.)

32023 (LA–4153) KIRKENDALL EFFECT IN SINTERED REFRACTORY METAL ALLOYS. Lenz, W. H.; Riley, R. E. (Los Alamos Scientific Lab., N. Mex.). Feb. 20, 1969. Contract W-7405-eng-36. 18p. Dep. CFSTI.

The evaluation and treatment of tungsten, tantalum, molybdenum, and rhenium powders as applied to this work are reviewed. Inefficient sintering of certain elemental powder combinations is ascribed to the Kirkendall effect, related to typical results when sintering mixtures of elemental tungsten, tantalum, molybdenum, and rhenium powders. Experiments involving the sintering of W–Mo–Re alloys made from elemental and prealloyed powders are presented to show the effect of powder characteristics as well as a wide range of sintering temperature and cycles. The results are related to physical and chemical composition of the ternary mixtures, and to sintering cycles, to reveal the conditions which minimize the Kirkendall effect. (auth)

32024 (ORNL–4421) SURVEY OF BERYLLIUM TECHNOLOGY AND NUCLEAR APPLICATIONS. Pih, Hui (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 72p. Dep. CFSTI.

A compilation of information is presented that is directed toward certain areas of the use of beryllium in nuclear applications that may be of particular interest to the designer of nuclear reactors. These areas include the effects of neutron irradiation by beryllium, the design considerations in the use of beryllium, and beryllium fabrication methods. (auth)

32025 ANALYSIS OF THE EXCESS VOLUMES OF LIQUID AND SOLID ALLOYS. Predel, Bruno; Emam, Ahmad (Univ., Muenster, Ger.). Z. Metallk., 60: 469-75(May 1969). (In German).

Making use of the excess volumes of binary alloys known at present a systematic analysis of the factors influencing the change in volume with alloying was carried out. Beside a contribution to the excess volume which is due to the change in binding conditions, a transformation term and a lattice distortion or misfit contribution have to be considered. An analogous consideration of the excess volumes of liquid alloys showed that in this case, too, an influence of misfit on the excess volume exists, even though it is less pronounced than in the solid state. In the systems In–Sn, Bi–Pb, Ag–Bi, and In–Pb a special analysis of the volume ratios was made. (auth)

32026 ELECTRODEPOSITION OF REFRACTORY METALS. Mellors, Geoffrey W.; Senderoff, Seymour (to Union Carbide Corp.). U. S. Patent 3,444,058. May 13, 1969. Filed Apr. 8, 1968.

Zirconium, tantalum, niobium, chromium, hafnium, tungsten, molybdenum, vanadium, and their alloys can be electrodeposited as dense, structurally coherent plates from a solution of the refractory metal fluoride in a molten alkali-fluoride eutectic mixture, having no appreciable concentrations of chlorides, bromides, and oxides. The process obeys Faraday's law and provides a coating essentially unalloyed with the substrate material. A soluble anode comprising the metal to be deposited is used. The metal to be deposited must first be present in the melt prior to producing the deposit as an ion in a sufficiently low valence state wherein the metal ion will not attack the deposited metal. (Offic. Gaz.)

Properties Evaluations

Refer also to abstracts 31494, 32022, 32025, 32041, 32042, 32045, and 33066.

32027 (AI-AEC–12770) SOLUBILITY OF BISMUTH IN LIQUID SODIUM. Gehri, D. C.; Sullivan, R. J. (Atomics International, Canoga Park, Calif.). June 1, 1969. Contract AT(04-3)-701. 22p. Dep. CFSTI.

The solubility of bismuth in liquid sodium was studied at 200 to 650°C, using a specially prepared Na_3Bi solute and a very-high-purity sodium. A capsule technique, involving a physical separation of the excess solute from the solution, was used for the experiments. Chemical analyses were performed, using atomic absorption spectrophotometry. The results were combined with those of two other laboratories, to yield two separate solubility expressions from which heats of solution have been individually calculated. The expressions recommended for describing the solubility of bismuth in liquid sodium in specific temperature ranges are given. One of these expressions was derived from data which may reflect the influence of Na–Bi–O interactions, and it should be used only with this qualification understood. No such restriction is placed on the other expression, which is therefore recommended without qualification for describing the solubility of elemental bismuth in sodium. (auth)

32028 (CEA-R–3771) HIGH TEMPERATURE ELASTIC CONSTANT MEASUREMENTS: APPLICATION TO PLUTONIUM. Bouchet, Jean-Marie (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1969. 69p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

An apparatus is described that was used to measure Young's modulus and the Poisson's ratio of several compounds from the resonance frequency of cylinders in the temperature range 0 to 700°C. The elastic constants of plutonium were studied and Young's modulus of Pu_δ and Pu_ϵ were measured as $E_{\delta\ 360°C}$ = 1.6 10^{11} dy/cm^2 and $E_{\epsilon\ 490°C}$ = 1.1 10^{11} dy/cm^2; σ_ϵ = 0.25 ± 0.03. The compressibility, the Debye temperature, the Grüneisen constant, and the electronic specific heat of Pu_ϵ were calculated using these results. (auth)

32029 (GAMD–8495) MATERIALS REVIEW: 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR FOR PUBLIC SERVICE COMPANY OF COLORADO. Hedgecock, P. D. (Gulf General Atomic, Inc., San Diego, Calif.). May 9, 1969. Contract AT(04-3)-633. 47p. Dep. CFSTI.

The structural materials selected for use in the 330-MW(e) high-temperature gas-cooled reactor nuclear generating station under construction near Platteville in Colorado were reviewed. Emphasis was placed upon the suitability of the materials for the anticipated 30-year operating life of the plant, bearing in mind the environmental conditions of radiation, temperature, fluids and gases, normal operating loads, and accident conditions Economic considerations of cost and availability have also been given very careful consideration. The review is in catalogue form and covers the principal structural materials used in those systems basic to the steam generating plant, inclusive of the nuclear reactor primary coolant system, and exclusive of the nuclear fuel, moderator, and reflector, and the steam turbine plant. Material specifications covering the principal features of chemical composition, product form, and mechanical properties are included. (auth)

32030 (NYO–3560-17) BIBLIOGRAPHY ON THERMAL EXPANSION IN INTERMETALLIC COMPOUNDS. Michel, D. J.; Ryba, E. (Pennsylvania State Univ., University Park. Dept. of Materials Science). June 1, 1969. Contract AT(30-1)-3560. 10p. Dep. CFSTI.

Expansion coefficients for 92 intermetallic compounds are listed. The compounds are arranged alphabetically giving structure type, if known; temperature range over which data are available; the expansion coefficients; and the reference. (51 references) (F.S.)

32031 (TID–25088) ULTRA HIGH VACUUM ADHESION TESTING OF NERVA ENGINE MATERIALS. First Annual Report. Aldrich, Robert G. (Syracuse Univ. Research Corp., N. Y.). July 1968. Subcontract No. 2907. 60p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

An investigation was initiated on the effects of surface cleaning, temperature, and deliberate gaseous contamination on the adhesion behavior of selected candidate materials for use in the NERVA nuclear rocket engine program. Using a torsion balance technique the relationship between the normal compressive load applied across crossed rod samples and the resultant contact resistance was used to ascertain the extent of adhesion under each set of experimental conditions. The material combinations 440-C vs 440-C, PO3 graphite vs PO3 graphite, pyrographite vs pyrographite, pyrographite vs ZTA graphite, were evaluated. Testing of the materials combination Ti vs Ti used for equipment calibration was completed. A partial study of the materials combination Ti/5Al/2.5 Sn ELI vs Ti/5Al/2.5 Sn ELI has been completed using both the standard static adhesion technique and a modified technique incorporating the effects of translatory motion on the adhesion behavior of this material. (auth)

32032 FATIGUE STRENGTH OF NUCLEAR PRESSURE VESSEL MATERIAL ASTM A 302 B STEEL AND ITS WELDED JOINTS. Sakabe Kiyozo; Tsukada, Hisashi (Japan Steel Works,

Ltd., Tokyo). Nippon Seiko Giho, No. 25, 2938-46(Feb. 1969). (In Japanese).

Strain controlled low cycle and high cycle fatigue tests were conducted on nuclear pressure vessel material ASTM A 302 B steel and its welded joints to study fatigue strength of materials used. The results analyzed on the basis of number of cycles to visible crack initiation and failure life, and were compared with the fatigue design curve in Sec. III of the ASME Code, the relation between total strain amplitude, ϵ_{ta} and number of cycles to visible crack initiation, N_c is obtained as the following formula $\epsilon_{ta} = C_p N^{-k_p} + C_e N^{-k_e}$; high cycle fatigue strength falls on the elastic amplitude, $\epsilon_{ea} - N_c$ line which is obtained in low cycle fatigue test, C_p in the formula $N^{k_p}\epsilon_{pa} = C_p$ which shows low cycle fatigue strength is a function of true fracture strain, ϵ_f in static tension properties, and the relation between C_p and ϵ_f for all materials tested is obtained as follows, $C_p = 0.45\,\epsilon_f$, the propagation life of a crack, $N_f - N_c$, is related to N_f, number of cycles to failure, by the formula of $N_f - N_c = \alpha N_f^{\beta}$, and the fatigue design curve in Sec. III of the ASME Boiler and Pressure Vessel Code may be regarded to have a safety factor of 2.5 for fatigue strength ratio K_f and 14 for failure life ratio R_L on base metal. On the other hand, the fatigue design curve in Sec. III of the ASME Code may be regarded to have a safety factor of 2.1 for K_f and 10 for R_L on the welded metal and softened zone, and to have a safety factor of 1.7 for K_f and 3.5 for R_L on bond zone. (auth) (NSA of Japan)

32033 EFFECT OF TUNGSTEN ADDITIONS ON THE PROPERTIES OF NEW HIGH MAGNETIC PERMEABILITY ALLOYS "NIMALLOY" IN NICKEL AND MANGANESE SYSTEM. Masumoto, Hakaru; Murakami, Yuetsu; Hinai, Masakatsu (Research Inst. of Electric and Magnetic Alloys, Sendai). Nippon Kinzoku Gakkaishi, 33: 488-92(1969). (In Japanese).

Effects of additions of various elements on the properties of nickel–manganese alloys were studied. The highest initial permeability of 76,000 and the highest maximum permeability of 441,000 were obtained. The results of experiments involving tungsten additions to nickel–manganese alloys show that the optimum cooling rate to attain the highest permeability in each alloy decreases gradually with increasing tungsten content. The alloys were baked for a long time at various temperatures below the order-disorder transformation point after slow-cooling from 900°C. With increasing tungsten content, the permeability of nickel–manganese alloys increases gradually and then rapidly attains a maximum value, after which it decreases gradually. The alloy consisting of 76.65% Ni, 19.23% Mn, and 4.12% W exhibits the highest initial permeability of 13,720 when cooled at a rate of 5°C/hr from 900°C and reheated at 380°C for 430 hr, and the highest maximum permeability of 60,700 when cooled at a rate of 3°C/hr from 900°C. The latter heat-treated alloy shows a magnetic hysteresis loss of 47.47 erg/cm³/cycle and a coercive force of 0.0321 Oe for the maximum magnetic induction of 5000 G, an intrinsic magnetic induction of 6232 G at an effective magnetic field of 900 Oe and an electrical resistivity of 58.7 $\mu\,\Omega$-cm at 20°C. (auth)

32034 EXPERIMENTAL DETERMINATION OF INTRINSIC RESISTIVE STRESS FOR TWINNING SURFACE DISLOCATIONS. Sumino, K. (Tohoku Univ., Sendai). Phys. Status Solidi, 33: 327-35(May 1, 1969).

The intrinsic resistive stress for twinning surface dislocations is determined from the analysis of the experimental results obtained in a previous paper (Phys. Status Solidi, 33: 317(1969)). The intrinsic resistive stress is expressed in terms of G'/G which is a ratio of the theoretical shear strength for twinning along a twin boundary to that in a perfect crystal. It is found that $G'/G < 0.20$ for 89 at. % manganese–copper alloy and $G'/G = 0.75 \times 10^{-2}$ for gold–46.1 at. % cadmium alloy. (auth)

32035 MECHANICAL BEHAVIOR OF CRYSTALS WITH TWINNED STRUCTURE. Aoyagi, T.; Sumino, K. (Tohoku Univ., Sendai). Phys. Status Solidi, 33: 317-26(May 1, 1969).

The internal friction and the stress–strain behavior are investigated on three kinds of materials which contain many twinned regions. A relaxation peak of internal friction with the activation energy (0.63 ± 0.03) eV is observed in an 89 at. % manganese–copper alloy. The peak is thought to be associated with the elementary process in the motion of surface dislocations (twin boundaries). Plastic flow possibly due to the motion of twinning surface dislocations is observed at relatively low stress level in this alloy. The relaxation peak is not found in gold–46.1 at. % cadmium and indium–21 at. % thallium alloys. Characteristics in a pseudo–elastic flow due to the motion of twinning surface dislocations are examined on the gold–cadmium alloy. (auth)

Structure and Phase Studies

Refer also to abstract 32041.

32036 (BMwF-FBK-68-61) TRANSFORMATION CHARACTERISTICS OF A Zr–4 WT. PERCENT V ALLOY. Lehmann, W. (Technische Hochschule, Munich (West Germany). Institut fuer Metallurgie und Metallkunde). Dec. 1968. 35p. (In German). Dep.

The $\beta \rightleftharpoons \alpha$-transformation in the zirconium-vanadium system was studied using hardness measurements, metallographic and x-ray diffraction techniques. It was found that the martensitic transformation is suppressed when the amount of vanadium exceeds the critical level of about 3 wt %. When the alloy content is higher, the β-phase cannot be quenched completely and β transforms partially into the athermal ω'-phase. A complete retention of β is not possible. The ω_s-temperature was found between 100 and 200°C, whereas the metastable ω'-phase decomposes during subsequent aging into $\alpha + ZrV_2$ and the retained β transforms primarily into the "aged" ω-phase. A direct transformation of β and α was found by quenching to temperatures above 530°C. Two TTT-charts show the various transformation-steps. (auth)

32037 (IS-Trans-80) PHASE DIAGRAM OF THE VANADIUM–COPPER SYSTEM. Savitskii, E. M.; Baron, V. V.; Duisemaliev, U. K.; Efimov, Yu. V. Translated from Vestn. Akad. Nauk Kaz. SSR, 20: No. 7, 38-44(1964). 10p. Dep. CFSTI.

The phase diagram of the vanadium-copper system was derived from the microstructural, thermal, x-ray diffraction analyses and study of the hardness, microhardness, and electrical resistivity of the melts. A wide region of immiscibility in the liquid and solid states, extending at a monotectic temperature of 1530°C from 13.6 to 96.0 at. % of Cu was found to exist in the system. Vanadium and copper form limited solid solutions. The solubility of copper in the vanadium at room temperature amounts to about 6 at. %. With increasing temperature, the solubility of copper in vanadium increases, reaching a maximum at about 8 at. % at 1530°C. The copper-based solid solution is formed according to the peritectic reaction $L_2 + \alpha \rightleftharpoons \beta$ at 1120°C. The highest solubility of vanadium in copper at the peritectic temperature amounts to 0.8 at. %, and at room temperature to about 0.1 at. %. No intermetallic compounds are formed in the system. Dissolution of copper in vanadium increases its hardness and sharply decreases its plasticity. Small amounts of vanadium increase the hardness and electrical resistivity of the copper. (auth)

32038 DISSOCIATION PRESSURE OF BISMUTH IN THE SYSTEM BISMUTH–THORIUM. Dahlke, Olaf; Gans, Wigbert; Knacke, Ottmar; Mueller, Franz (Technische Hochschule, Aachen. Kernforschungsanlage, Juelich, Ger.). Z. Metallk., 60: 465-8(May 1969). (In German).

The dissociation pressure of bismuth in the system bismuth-thorium was determined using the effusion method of Knudsen between 600 and 1400°C. Isothermal dissociation curves and x-ray diagrams corroborated the compounds $ThBi_2$ and Th_3Bi_4 which do not form solid solutions. For ThBi a narrow range of homogeneity between $ThBi_{1.03}$ and $ThBi_{0.8}$ is indicated. The supposed compound Th_2Bi was not found using measurements of the partial pressure. The values of $\log (p_{Bi} + p_{Bi_2})$ were given for the vapor pressure and for the pressure of dissociation of bismuth in the univariant equilibria. (auth)

32039 EVIDENCE FOR THE EXISTENCE OF AN ALUMINIUM–ZIRCONIUM PHASE IN A ZIRCONIUM-CONTAINING ALUMINIUM–ZINC–MAGNESIUM ALLOY. Thundal, B.; Sundberg, R. (Aktiebolaget Atomenergie, Finspong, Sweden). J. Inst. Metals, 97: 160(May 1969).

A transmission electron microscopy study of the effect of 0.1% Zr additions to a pressure-quenched and aged Al–4% Zn–1.30% Mg–0.20% Mn alloy revealed unevenly distributed precipitates, 300 to 700 Å dia, coherent with the matrix. Similar precipitates were identified during the aging of an Al–0.47% Zr alloy. It is suggested that they are a metastable phase preceding Al_3Zr. (UK)

Radiation Effects

Refer also to abstracts 32560, 32561, and 33117.

32040 (BNWL-678) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August–October 1967. Claudson, T. T. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 336p. Dep. CFSTI.

Results of investigations are presented on radiation effects on stainless steel, steel, cobalt alloys, chromium steel, tungsten, Hastelloy X, Incoloy 800, Hastelloy R235, aluminum–iron alloys, A-286 alloy, Hastelloy N, Inconel, niobium base alloys, and iron. Information is included on reactor pressure vessels, impact

shock testing of metals, radiation detection foils, EBR II operation, and in-pile gas loop development. (J.R.D.)

32041 (CEA-R-3607) DISLOCATIONS AND RADIATION DAMAGE IN α-URANIUM. Leteurtre, Jean (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 147p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

Dislocations in α-uranium were studied by electron microscopy. Electropolishing thin foils was performed at (-110°C) to prevent oxidation. Burgers vectors of twin dislocations were defined. Interactions between slip and twinning were studied experimentally and theoretically. Samples irradiated at various burnup levels were examined. In order to explain the micrographic results, and informations gathered in literature about radiation damage in α-uranium, a coherent model was proposed for the fission particle effects. The influences of temperature, dislocation density, and impurity content were examined. The number of point defects created by one initial fission was determined for pure and annealed metal. The importance of self-anneal which occurs immediately in each displacement spike, and the anneal due to a new fission on the damage resulting from a previous fission are estimated. The focussing distance in [100] direction is found to be about 1000 A, at 4°K. (auth)

32042 (TRG-Report-1786) THE STRENGTH OF Zr-2½% Nb ALLOY IN THE ANNEALED AND COLD-WORKED CONDITION. Murgatroyd, R. A.; Winton, J. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). Oct. 22, 1968. 19p. (CONF-670909-10; HWR-FEMWG/P-(68)355). Dep.

From International Conference on the Strength of Metals and Alloys, Tokyo, Japan.

The development of cold-worked Zr-2½% Nb for use as pressure tube material is described. The mechanical properties of cold-worked Zr-2½% Nb are given and a comparison with cold-worked Zircaloy-2 is made, which shows that the strength of Zr-2½% Nb both at 20 and 300°C is the greater by 10 to 20,000 psi. Irradiation at 300°C to doses of 5.2×10^{20} n/cm^2 (Ni) increased the strength of both Zr-2½% Nb and Zircaloy-2 by about 30,000 psi. Creep data for pressure tube material are given for 300°C, which fit the equation $\epsilon = 1.45 \times 10^{-6} s^{2.5} t^{\frac{1}{4}}$. X-ray and transmission electron microscopy results are presented which show that the observed strengthening in Zr-2½% Nb may be attributed to Nb and O_2 in solid solution, to precipitation in the α-Zr phase during cooling, and to cold work. Aging at 400°C and below causes further precipitation, which explains the strengthening observed after autoclaving, while aging above 400°C causes rapid over-aging and softening. (auth) (UK)

32043 (WANL-TME-1860) TENSILE PROPERTIES OF IRRADIATED Ti-5 PERCENT Al-2.5 PERCENT Sn ELI AT CRYOGENIC TEMPERATURES. Shogan, R. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Nov. 1968. Subcontract NP-1. 29p. Dep. CFSTI.

Tensile specimens of Titanium-5% Aluminum-2.5% Tin ELI (Extra Low Interstitial) alloy were irradiated at the Ground Test Reactor in test GTR-19 to fluences of 5.6 to 11×10^{17} n/cm^2 (E > 1 MeV). The irradiation temperature was 140°R. Ultimate and yield strengths increased slightly while the notched strength was unaffected. At 140°R the percent elongation of specimens from a forging was significantly, though not seriously, reduced. Sheet specimens showed slight reductions in elongation, while that of the welded sheet specimens increased. About 60% of the radiation damage effect is annealed out at room temperature. Most of this recovery occurs within one hour. Complete annealing occurred after one hour at 1000°R. (auth)

32044 NEUTRON IRRADIATION EFFECTS ON THE PLASTIC PROPERTIES OF PURE IRON. Kitajima, Kazunori; Futagami, Koji (Kyushu Univ., Fukuoka). Rep. Res. Inst. Appl. Mech. (Kyushu Univ.), 16: 283-93(1968).

Stress-strain characteristics together with internal frictions were measured on pure iron single crystals containing < 0.1, 1 and 20 ppM carbon and irradiated to doses of 0, 1.8×10^{17}, 1.3×10^{18} and 1×10^{19} nvt (>1 MeV) at temperature ~70°C. The increases of yield stress at small strain and subsequent flow stress at larger strain were interpreted as caused mainly by barriers of irradiation defects against the movements of edge and screw dislocations based on the fact that the latter has much larger Peierls stress than the former. Appreciable decrease of activation volume associated with the flow stress observed in irradiated specimens was attributed to the process of screw dislocation overcoming Peierls hill near the top of irradiation defects of sufficiently small size, presumably such as triplet of interstitials or small dislocation loop invisible by electron microscope. The increase of the flow stress was estimated and shown to coincide with the observed value. The carbon content was found to have little effect on hardening in an irradiated condition within the dose of $<1.3 \times 10^{18}$ nvt, though carbon gave a large effect in the course of recovery of yield stress and internal friction after annealings. Explanations are presented for evidence based on the mechanisms of trapping and detrapping of carbon atoms in vacancies and other defects during annealing. (auth) (NSA of Japan)

32045 PREIRRADIATION AND POSTIRRADIATION MECHANICAL PROPERTIES ON HASTELLOY N WELDS. McCoy, H. E.; Canonico, D. A. (Oak Ridge National Lab., Tenn.). Weld. J. (N. Y.), 48: 203s-11s(May 1969).

Welds were made by the gas tungsten-arc process in several heats of Hastelloy N. The mechanical properties of transverse weld samples and the base metal were compared in tensile tests over the range of 75 to 1600°F and in creep tests at 1200°F. The as-fabricated welds exhibited lower fracture strains than the base metal under all test conditions, but the properties of the welds were improved markedly by postweld heat treatments. The post-irradiation tensile and creep properties of the welds and base metal at elevated temperatures were about the same, although the properties were widely different before irradiation. (auth)

Ceramics and Cermets

Refer also to abstract 32040.

32046 KINETICS OF REACTIONS IN IONIC SYSTEMS. Proceedings of an International Symposium on Special Topics in Ceramics, Held at Alfred, N. Y., June 18-23, 1967. Gray, T. J.; Frechette, V. D. (eds.). Materials Science Research, Volume 4. New York, Plenum Press, 1969. 581p. $27.50. (CONF-670625).

A total of 33 papers were presented at the Symposium. A separate abstract was prepared for each of five papers. Papers for which no abstracts were prepared are concerned with solid state chemistry, thermal decomposition, grain growth, thermal analysis, salt hydrate crystals, photolysis glasses, K precipitation, ferroelectrics, crystal growth Al_2O_3 surface diffusion, grain boundary grooving, oxide behavior, sintering, crystallization, and high-temperature dissolution. (J.R.D.)

For abstracts of individual papers see: 32017, 32050, 32051, 32064, and 32065.

Preparation and Fabrication

Refer also to abstracts 32016 and 32026.

32047 (BAW-3714-12) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 10, November 1968-January 1969. Dewell, E. H. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). June 1969. Contract AT(30-1)-3714. 65p. Dep. CFSTI.

The preparation of (U, 20% Pu)O_2 sol-gel spherical fuel in two size ranges for thermal reactor testing is complete. Two uranium enrichments—depleted UO_2 and 20% enriched $^{235}UO_2$—were used to prepare materials that will yield two different heat rates with fuel of the same U/Pu ratios. Also completed is the first irradiation capsule test in a series designed to show differences in the restructuring kinetics of pellets and vibratory compacted spheres and shards; the heat rate was 16.7 kW/ft, and the capsule received 9.3 EFPD. The capsule is cooling pending hot cell examination. The procedures for moisture determination and oxygen stoichiometry in mixed oxide fuels are summarized. Measurements of the gas contents and densities of irradiation specimens are complete. A stainless steel and Homalite glove box for examination of sub-kilo quantities of reactor-exposed plutonium-bearing fuels is described. The equipment hot cell and laboratory used for the sol-gel process are also discussed. (auth)

32048 (CEA-R-3745) PILOT PRODUCTION OF 325 kg OF URANIUM CARBIDE. Clozet, Christian; Dessus, Jacques; Devillard, Jacques, Guibert, Michel; Morlot, Guy (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1969. 43p. (In French). Dep.

The pilot fabrication of uranium carbide rods to be mounted in bundles and assayed in two channels of the EL 4 reactor is described. The fabrication process includes production of uranium carbide granules by carbothermic reduction of uranium dioxide; electron bombardment melting and continuous casting of the granules; machining of the raw ingots into rods of the required dimensions; and assembling the rods to make the fuel elements. Both qualitative and quantitative results of this pilot production chain are discussed. (auth)

32049 (LA-4156-TR) DICARBIDES OF EUROPIUM AND OTHER RARE-EARTH METALS. Matiushenko, N. N.; Svina-

renko, O. P. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.). from Ukr. Fiz. Zh., 13: 1083-5(1968). 4p. Dep. CFSTI.

Europium dicarbide is obtained in the Eu_2O_3-C system at 1800°K. It has the face-centered cubic cell with $a = 0.596_{1+1}$ nanometers (nm). The volume of the europium dicarbide is compared with volumes of the well-known rare-earth metal dicarbides. The decrease of 0.006 nm^3 from additivity is established for EuC_2, BaC_2, and CaC_2. The volume variation is connected with an electron structure of rare-earth elements. (auth)

32050 BEHAVIOR OF OXYGEN IN OXIDES DURING SINTERING. Condit, R. H. (Univ. of California, Livermore). pp 362-74 of Kinetics of Reactions in Ionic Systems. Gray, T. J.; Frechette, V. D. (eds.). New York, Plenum Press, 1969.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y. See CONF-670625.

The need for studying details of the transport mechanisms during sintering is outlined. A technique for doing this is proposed which makes use of the nuclear activation of the rare isotope of oxygen ^{11}O so that it can be used as if it were in effect a radioactive tracer. A test of the feasibility of the use of this as a marker in the region of neck growth between grains of ceramic material is reported. (auth)

32051 DENSIFICATION KINETICS DURING NONISOTHERMAL SINTERING OF OXIDES. Morgan, C. S. (Oak Ridge National Lab., Tenn.). pp 349-61 of Kinetics of Reactions in Ionic Systems. Gray, T. J.; Frechette, V. D. (eds.). New York, Plenum Press, 1969.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y. See CONF-670625.

The initial densification kinetics in the sintering of powder compacts have been examined for five oxides: ZrO_2-CaO, MgO, CaO, CeO, and SiO_2. Study of the initial sintering, the densification which occurs as the temperature of the specimen is increased, permits the observation of densification kinetics which may not be diffusion controlled. The densification kinetics demonstrate several features which are not compatible with a diffusion-controlled process. For example, there is a disproportionately large increase in the densification rate when the temperature is increased compared with that expected from a volume diffusion process. Other tests indicate that isostatic pressing of partially sintered powder compacts causes densification on subsequent heat treatment. An explanation of these effects by a diffusion sintering process, either volume or grain boundary diffusion, is not evident; however, a qualitative explanation based on dislocation transport of material can be proposed. This explanation rests on the premise that as the temperature is increased, the stress required for motion and generation of dislocations decreases. (auth)

32052 FORMATION AND REACTIVITY OF BORIDES, CARBIDES, AND SILICIDES. I. REVIEW AND INTRODUCTION. Glasson, D. R.; Jones, J. A. (Plymouth Coll. of Tech., Eng.). J. Appl. Chem. (London), 19: 125-37(May 1969).

Borides, carbides and silicides are reviewed with special reference to newer production methods and fabrication techniques. Crystal structures and types of bonding in binary and ternary compounds are classified and discussed. The scope and limitations of the Pauling–Rundle theory, molecular orbital treatment and the Ubbelohde–Samsonov theory are examined critically and appropriate experimental evidence is summarised. Information so far available on the sintering of borides, carbides, and silicides is summarised in relation to their chemical reactivity. The sintering is influenced by additives or impurities such as oxides formed by partial hydrolysis and oxidation. Resistance to oxidation is increased by sintering and hot pressing the refractories, but since the affinity of the metals is exclusively higher for oxygen, exchange reactions diminish the quality of the materials. Boride and carbide coatings generally have poor resistance in air or oxygen, but some silicides are more suitable. The kinetics and products of oxidation of borides, carbides and silicides so far studied depend mainly on the intrinsic reactivity of the material and the available surface at which oxidation can occur. (auth) (UK)

32053 FORMATION AND REACTIVITY OF BORIDES, CARBIDES, AND SILICIDES. II. PRODUCTION AND SINTERING OF BORON CARBIDE. Glasson, D. R.; Jones, J. A. (Plymouth Coll. of Tech., Eng.). J. Appl. Chem. (London), 19: 137-40 (May 1969).

The principal methods of boron carbide production are compared and their thermodynamics are examined. Mechanism of carbide formation and sintering of the products are discussed. High-purity stoichiometric B_4C of submicron size was produced on a semi-technical scale by reduction of diboron trioxide with carbon and magnesium. Rates of sintering were determined from changes in surface areas and average crystallite and aggregate sizes. Sintering of boron carbide was enhanced by increased temperature and time of calculation. Addition of chromium accelerated sintering at temperatures above 1600° and especially at 1800°. For more extensive sintering, the submicron powders from the magnesium reduction process were more suitable than the coarser samples given by the electro-thermal carbon reduction; the latter required ballmilling to provide suitable grain size composition for effective hot pressing. (auth) (UK)

32054 REFRACTORY MATERIAL. (to Societe Industrielle de Combustible Nucleaire). British Patent 1,153,757. May 29, 1969. Priority date July 9, 1965, France.

A method is described for producing refractory materials for use as crucibles, molds, stoppers, or vessels to contain reactive liquid alloys or metals such as uranium. The refractory material may consist of a fused mass of a rare earth oxide, a binary mixture of 2 rare earth oxides, or a rare earth oxide and zirconium oxide. (F.S.)

32055 RADIATION RESISTANT SEMICONDUCTOR GRADE SILICON CONTAINING A METAL OXIDE. Mayer, Simon Ernest (to Trancoa Chemical Corp.). U. S. Patent 3,444,100. May 13, 1969. Filed Oct. 30, 1963.

Radiation resistant single crystal semiconductor grade silicon materials containing metal oxides are described. From 0.005 to 0.1% of titanium dioxide, zirconium dioxide, or niobium dioxide is incorporated in the silicon material to produce the radiation resistant material. (Offic. Gaz.)

32056 PROCESS FOR PREPARING HIGH DENSITY URANIUM DIOXIDE PARTICLES AND COMPOSITIONS. Fitch, Frederick T.; Shoup, Robert D. (to W. R. Grace and Co.). U. S. Patent 3,444,088. May 13, 1969. Filed Feb. 24, 1967.

A process is described for preparing sintered, high density, uranium dioxide particles from uranium trioxide aquasols by treating the aquasol with hydrogen peroxide or a polyhydric alcohol before drying or drying the uranium trioxide particles and rehydrating before reduction and sintering, or a combination of these process steps. (Offic. Gaz.)

32057 FABRICATION OF NUCLEAR FUEL RODS BY VIBRO-COMPRESSION OF MONODIMENSIONAL CERAMIC POWDERS. van Asbroeck, Ph.; Wieczorkowski, M. (Centre d'Etude de l'Energie Nucleaire, Mol-Donk, Belg.). Rev. Met. (Paris), 66: 63-9(Jan. 1969). (In French).

The method for fabrication of elements comprises vibrationally compacting powders poured into the tube of a rod case. Economy of construction is improved by reducing the number of granulometric fractions and using small cylindrical fritted pellets. Characteristics of starting materials, conditions of filling, and conditions for packing by pneumatic vibrations are defined. Cylindrical pellets of chosen sizes are adaptable to compression by shock. The packing results in a rearrangement and fragmentation of the particles and allows a density of 85% of the theoretical value to be reached. There may be a longitudinal variance of 3% of theoretical density. Density in filling is a direct function of relative particle dimensions; mobility of particles in filling is inversely proportional to relative particle dimension. Distribution of particles varies between a helical and a vertical structure. (BBB)

Properties Evaluations

Refer also to abstract 32049.

32058 CERAMIC MATERIAL. Viskov, A. S.; Zhdanov, G. S.; Venevtsev, Yu. N.; Petrov, V. M. Russian Patent 222,230. (In Russian).

A ceramic material containing bismuth and lead oxides is introduced. To raise both the thermal stability and the dielectric constant the material contains tantalum pentoxide to satisfy the stoichiometric composition Pb_2BiTaO_6. (JPRS)

32059 CERAMIC MATERIAL. Shvorneva, L. I.; Venevtsev, O. N.; Petrov, V. M.; Zhdanov, G. S. Russian Patent 222,231. (In Russian).

A ceramic material containing divalent lead, trivalent iron, and pentavalent tantalum is introduced. To increase the nonlinearity of the dielectric constant, the material will contain an excess of the lead component in amounts ranging from 4 to 6 mole percent to satisfy the stoichiometric composition $Pb(Fe^{1}/_{2}\ Ta^{1}/_{2})O_3$. (JPRS)

32060 CERAMIC MATERIAL. Viskov, A. S.; Petrov, V. M.; Venevtsev, Yu. N.; Zhdanov, G. S. Russian Patent 222,228. (In Russian).

A ceramic material containing BaO and Bi_2O_3 is introduced. In order to increase both the thermal stability and dielectric constant, the material will contain Ta_2O_5 to meet the stoichiometric composition $BaBiTaO_6$. (JPRS)

32061 EFFECTS OF GRAIN SIZE AND CARBON CONTENT ON THE STRENGTH OF WC–10 PERCENT Co ALLOYS. Suzuki, Hisashi; Hayashi, Kozi; Kawakatsu, Ichiro (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 33: 504-9(1969). (In Japanese).

The transverse-rupture strength of WC–10% Co alloys has been investigated in relation to their mean grain size and carbon contents using the specimens having higher strength. The specimens were vacuum-sintered under controlled conditions. The mean grain size of WC ranged from 1.4 to 4.5 μ. The alloy exhibited the highest strength at the mean grain size of about 2.0 ~ 2.2 μ, and the arithmetic mean value reached 350 ~ 370 kg/mm^2 according to the test of ASTM standard. It was confirmed that the strength was also affected by the carbon content. The strength vs grain size curves as well as the measured value of the strength appeared to be changeable, depending on both the testing methods and the strength level of specimens. On the fracture surface of each alloy, the region containing the starting point of that fracture was macroscopically observed in the inner region a little apart from the tension-surface. The region is silver colored. (auth)

Structure and Phase Studies

Refer also to abstract 32070.

32062 (COO–1198-631) STUDY OF PRECIPITATION IN NIOBIUM–NITROGEN ALLOYS. Hennessy, Daniel Roger (Illinois Univ., Urbana). June 1969. Contract AT(11-1)-1198. 33p. Dep. CFSTI.

Thesis.

Results of the investigations indicate that linear growth rates of precipitate thickening at subgrain boundaries have activation energy of 5.6 kcal/mole, which is less than the accepted value reported for bulk diffusion of nitrogen in niobium signifying that the simple discontinuous precipitation theory does not apply. Results from electron microscopy suggested a coarsening process initiating at the subgrain boundary precipitates. In a proposed discontinuous coarsening model, the sub-boundary precipitates thicken by diffusion of dissolved nitrogen from the matrix, across a denuded region, to the larger subgrain boundary precipitates. (auth)

32063 (COO–1198-634) MICROPROBE ANALYSIS OF PHASES IN Nb–N ALLOYS. Savage, Howard (Illinois Univ., Urbana). June 1969. Contract AT(11-1)-1198. 41p. Dep. CFSTI.

Thesis.

The compositions of nitride and solid solution phases in equilibrated Nb–N alloys and an equilibrium specimen of a Nb 0.86 wt % Zr-3 6 wt % N alloy were measured by microprobe analysis. Hardness readings were made on all the specimens. Specimens were prepared to minimize oxygen contamination and to provide representative materials for analysis. The phases studied in the equilibrated specimens were the metal-nitrogen solid solution and the dispersed and grain boundary precipitate, Nb_2N. A brief description of the microprobe analysis was given. It was found that matrix compositions can be determined using the microprobe analyzer, but not to as great a precision as by internal friction studies; nitride phases are satisfactorily analyzed provided they are massive enough and are equilibrated for sufficiently long times; the distribution of a minor element (Zr) in an alloy can be traced effectively even when present in fractions of a wt %; standard specimens of reactive elements must be carefully prepared and polished just prior to analysis and in the absence of water to prevent troublesome surface layers; and compound standards for elements such as nitrogen must be characterized and analyzed initially to determine the amount of the element present. (auth)

32064 CRYSTAL GROWTH IN CERAMIC POWDERS. Oel, H. J. (Max Planck Institut fuer Silikatforschung, Wuerzburg, Ger.). pp 249-72 of Kinetics of Reactions in Ionic Systems. Gray, T. J.; Frechette, V. D. (eds.). New York, Plenum Press, 1969.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y. See CONF-670625.

The importance of crystal size as opposed to particle size in powders and in polycrystalline solids is discussed. Crystal growth may be followed throughout a complete ceramic fabrication process. Optical methods for determining crystal size distributions are reviewed and an x-ray method is described in detail. The importance of determining distributions instead of average values for studying the process of crystal growth is emphasized. Experimental results for crystal growth in powders (tempering, calcination) and in powder compacts and polycrystalline bodies (sintering) are compared with the rate law as derived from thermodynamic and kinetic considerations. In all cases which were investigated agreement was good. It may be concluded that crystal growth in crystalline systems is governed by a theoretical rate law with the kinetic factor depending on the material, the area of contact, and on temperature. (auth)

32065 DIFFUSION PATH NETWORKS IN OXIDES. Condit, R. H. (Univ. of California, Livermore). pp 284-303 of Kinetics of Reactions in Ionic Systems. Gray, T. J.; Frechette, V. D. (eds.). New York, Plenum Press, 1969.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y. See CONF-670625.

An understanding of diffusion mechanisms in oxides, particularly cation diffusion, must take account of the various possible paths which an atom may follow in going from one normally occupied site to another equivalent site. Such paths may be branched and will likely include stops at metastable points along the way. Methods are described whereby path networks within oxides can be characterized. Diffusion in the structures NaCl, ZnS, FeS, and BeO is discussed. (auth)

32066 PHASE EQUILIBRIA OF NICKEL-RICH NICKEL–GALLIUM–BORON ALLOYS. Stadelmaier, Hans H.; Fiedler, Maria-Luise (North Carolina State Univ., Raleigh). Z. Metallk., 60: 447-8(May 1969). (In German).

In the nickel corner of the ternary system nickel-gallium-boron, equilibria during solidification and at 800°C were investigated. At a boron content above 21 at. % the τ boride contains 6.5 to 12 at. % Ga and has a lattice constant that varies from 10.481 to 10.519 Å. Two additional borides of unknown structure were observed. (auth)

32067 NEW COMPOUNDS IN THE SYSTEMS La_2O_3–SrO AND Ce_2O_3–SrO. Lopato, L. M.; Pavlikov, V. N.; Lugin, L. I. Zh. Neorg. Khim., 14: 861-2(Mar. 1969). (In Russian).

Compounds of the composition $La_2O_3 \cdot 2SrO$ and $Ce_2O_3 \cdot 2SrO$ were obtained as result of 6-hr synthesis in an environment of argon at 1650°C and hydrogen at 1600°C, respectively. On melting, decomposition of the compound occurs with the formation of two-phase mixtures of solid solutions. A comparison of data indicated isostructurally corresponding compounds in both systems. (M.C.G.)

Radiation Effects

Refer also to abstract 33066.

32068 (BMI–1854) DEVELOPMENTS IN THE TECHNOLOGY OF NUCLEAR FUELS DURING AUGUST–OCTOBER 1968. Keller, Donald L.; Chubb, Walston (Battelle Memorial Inst., Columbus, Ohio). Nov. 1, 1968. Contract W-7405-eng-92. 90p. Dep. CFSTI.

Four samples of bulk UO_2 exhibited columnar grain growth and signs of lenticular void formation at temperatures near 1500°C. Saturation of swelling was observed at volume increases ranging from 6 to 20 percent at burnups below 1×10^{20} fissions per cm^3. Surface temperatures decreased from 1750 to 1440°C as the irradiation progressed. Since swelling remained saturated after a burnup of 1×10^{20} fissions per cm^3 and since mainly large voids and columnar grains appear in the postirradiation microstructures, it must be presumed that the processes of grain growth and gas release remained active as surface temperatures decreased to 1440°C. Two of the above samples of UO_2 were vented to internal plenums by 0.110-in. axial holes; the other two were vented to internal plenums by tantalum tubes extending to their geometric centers. The latter swelled 6 to 12 vol % whereas the former swelled 15 to 20 vol %. Examination has indicated that the tantalum tubes acted to change the thermal profile so as to produce an annular void rather than a central void in these samples. The increased surface area and shortened path for gas release are presumed to be the primary causes of the improved stability of the UO_2 specimens containing the tantalum tubes. A liquid copper-UC cermet showed diametral increase of 4 percent at a burnup of 1.6×10^{20} fissions per cm^3 at temperatures ranging from about 1500 to 1300°C. This swelling, which is much less than that of bulk UC or solid UC cermets but is much greater than that expected of a semifluid fuel, is apparently caused by the separation of the cermet into an annular ring of solid UC on the inside surface of the cladding plus a central core of copper-rich liquid. The use of a 10-mil annular gap around a bulk UC specimen proved to be totally useless as a method of preventing cladding strain at a surface temperature of about 1600°C. The gap was closed (presumably

caused by the insulating effect of the gap) at a burnup of less than 0.16×10^{20} fissions per cm^3, and swelling proceeded to a burnup of 1.7×10^{20} fissions per cm^3 at a rate as high or higher than if the gap had never existed. Two UN specimens with a 6-mil annular gap between the fuel and the cladding showed closure of the gap and virtually no external swelling to burnups of about 0.7×10^{20} to 1.1×10^{20} fissions per cm^3 at surface temperatures between 1630 and 1945°C. A sudden increase in the swelling rate and failure of these specimens at higher burnups remains unexplained. Saturation of swelling is observed in UN at surface temperatures between 1600 and 1900°C at burnups near 1×10^{20} fissions per cm^3 at total porosities near 27 percent. If the porosity is introduced prior to irradiation, the external swelling is reduced by approximately that amount. Two samples of 85 percent dense UN showed external volume changes of 11 to 13 percent after irradiation to 1.7×10^{20} fissions per cm^3 at about 1800°C. Two samples of porous, fine-grained UC–ZrC are showing markedly improved dimensional stability at 1700°C compared with dense, unalloyed UC. Volume increases of 6 to 10 percent have been observed for the UC–ZrC samples at a burnup of 1.6×10^{20} fissions per cm^3 compared with volume increases of about 35 percent at the same burnup in dense, unalloyed UC. It is suggested that stationary fission-gas bubbles can grow by accretion of new gas atoms or by dissolution of the smaller bubbles and growth of a lesser number of larger bubbles. Estimates of the rates of these processes suggest that the latter process is not significant out-of-pile, but it is considered that fission-induced re-solution may make it significant in-pile. A reduction to one-third of the out-of-pile creep strength of UC at 1700°C is required to make the mechanical model approximate the swelling behavior of UC. Critical examination of the model suggests that this is not the result of a fault in the model but is probably a real effect of the fission event on the strength of UC. (auth)

32069 (BNWL-SA-1690) FUEL MOTION RESTRICTOR SCREENING CAPSULE IRRADIATIONS. Pember, L. A.; Crawford, R. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 11, 1968. Contract AT(45-1)-1830. 4p. (CONF-681101-25). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

A series of tests were made at the MTR to determine the compatibility of restrictor materials with mixed fuel oxides and the effectiveness of fixed and floating plugs in limiting axial fuel motion and slumping during incidents which result in fuel melting. Metal restrictors of Mo, Ni, 304 stainless steel, and W were evaluated along with ceramic restrictors of ThO_2, depleted UO_2, and ZrO_2. In all cases metal restrictors inhibited axial fuel motion regardless of restrictor material or geometry. Ceramic restrictors reacted with the fuel and failed to prevent slumping. (F.S.)

32070 (CEA-R-3795) STRUCTURES AND PROPERTIES OF $(U,Pu)O_2$ CONTAINING NON-ACTIVE FISSION PRODUCTS. A SIMULATION OF IRRADIATED NUCLEAR FUEL. Schmitz, Franz (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr. 1969. 41p. (In French). Dep.

Oxides with the same uranium and plutonium content, the same stoichiometry, and the same fission product content as an oxide fuel $(U_{0.8}Pu_{0.2})O_{1.96}$ after 2 per cent burnup were prepared. The stoichiometry changes due to irradiation were calculated and the calculation using x ray parameter measurements were checked. The contraction of the oxide lattice due to fission products in solid solution was calculated and measured. Microprobe analysis of precipitates was made and the results used to identify non metallic barium containing compounds and showed the particular behavior of molybdenum. Physical properties such as the electrical resistivity, the thermal diffusivity, and the vapor pressure of zirconium in solid solution were measured. (auth)

32071 THE COMBUSTION OF NUCLEAR FUELS OF OXIDES, SOME CONSIDERATIONS MAINLY FROM THE VIEW POINT OF THEIR CHANGES OF THE THERMAL CONDUCTIVITY. Nishijima, Toraji (Tokyo Shibaura Electric Co.). Funtai Oyobi Funmatsuyakin, 15: 329-40(Dec. 1968). (In Japanese).

The thermal generation in burning of the oxide-fuels in nuclear reactors for generation of electric power is based on the nuclear fission of fuels themselves. The burning process is reviewed from the point of changes in thermal conductivity (T.C.), by correlating it to changes of macro- and microscopic structures. Concerning the change of T.C. due to the change of temperature of UO_2, measurements inside and outside of the furnace are given, and the effects of irradiation, the change of T.C. at each region of temperatures, and the interpretation for the observed phenomenon are discussed in relation to the thermal conduction mechanism. The structural changes altering T.C. are affected not only by irradiation, but also by the temperature gradient. The thermal diffusion in the multi-components system consisting of the products by nuclear fission and the microscopic considerations for the decline of T.C. at the initial stage of nuclear fission are described. It is concluded that the burning process of oxide-fuels is associated with the exothermic reaction of nuclear fission, which does not affect the nuclear fission itself. (NSA of Japan)

Plastics and Other Materials

Refer also to abstract 31586.

32072 (CEA-R-3730) IRRADIATION TESTS ON BITUMEN AND BITUMEN COATED MATERIALS. Tabardel-Brian, Renee; Rodier, Jean; Lefiliatre, Guy (Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule). Apr. 1969. 30p. (In French). Dep.

The use of bitumen as a material for coating high-activity products calls for prior study of the resistance of bitumen to irradiation. The methods of preparation of bitumen-coated products are summarized and the equipment which was used for carrying out the β and γ irradiations of these products is listed. Analytical results obtained as a function of the dose rates chosen and of the total integrated dose are given. Conclusions are drawn concerning the best types of bitumen. Some bitumens underwent no degradation nor volume increase for a total integrated dose of 1.8×10^{10} rads. (auth)

32073 A METHOD OF INVESTIGATING THE RADIATION RESISTANCE OF HYDRAULIC-SYSTEM FLUIDS. Zaslavskii, Yu. S.; Shor, G. I.; Zhukov, N. A.; (and others). Tr. Vses. Nauch.-Issled. Inst. Perarab. Nefti, No. 10, 290-8(1967). (In Russian).

A comprehensive method for investigating and estimating the radiation resistance of fluids in hydraulic systems is presented. The method includes irradiation under static and dynamic conditions. It is established that the viscosity and acid value of all the three investigated specimens of hydraulic-system fluids vary identically following irradiation with the same doses of the gamma radiation of cobalt-60 and combined neutron-and-gamma radiation of a nuclear reactor. The viscosity of the investigated specimens of hydraulic-system fluids when subjected to irradiation under dynamic tests decreases to a greater extent than when subjected to irradiation under static conditions. (JPRS)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 32692.

32074 FAR-INFRARED OBSERVATIONS OF THE NIGHT SKY. Houck, J. R.; Harwit, Martin (Cornell Univ., Ithaca, N. Y.). Science, 164: 1271-3(June 13, 1969).

A telescope cooled to liquid-helium temperatures was flown and far-infrared observations of the night sky were made. A gallium-doped germanium detector, sensitive from 5.2 to 130 micrometers, detected a minimum signal of 10^{-9} watt/cm^2/ster referred to 100 micrometers. The origin of this signal can be instrumental, atmospheric, interplanetary, or interstellar. A firm upper limit can be placed on the color temperature of a dilute cosmic background flux. (auth)

Cosmic Ray Exposure Ages

32075 TRITIUM AND ^{39}Ar IN STONE AND IRON METEORITES. Charalambus, St.; Goebel, K.; Stoetzel-Riezler, W. (CERN, Geneva). Z. Naturforsch., 24a: 234-44(Feb. 1969).

Tritium and ^{39}Ar measurements of stone and iron meteorites are reported and discussed. The tritium values of stone meteorites are in general higher than those found in other laboratories. The tritium decay rates in irons were low but a relatively high tritium value was measured in the rim of the meteorites. Factors which may influence the production rates are discussed and it is concluded that the average cosmic-ray flux which irradiated the meteorites must be at least a factor of two higher than the values reported by MacDonald for the cosmic-ray intensity at the top of the atmosphere. (auth)

Stars

Refer also to abstract 32690.

32076 (CONF-681032-, pp 213-23) HEAVY ELEMENTS IN STARS. Huizenga, John R. (Rochester Univ., N. Y.).

Theories of element formation in the stars are briefly reviewed and some of the evidence for heavy element formation in the stars is examined. The s and r processes are considered in some detail. Theories on the processes taking place in supernovae are mentioned. (W.D.M.)

32077 SPECTROPHOTOMETRY OF F STARS. II. ATMOSPHERES OF 41 CYG AND ν HER. Kipper, T. A. (Inst. of Physics and Astronomy, Tartu). Astrophysics (Engl. Transl.), 3: 185-93(Fall 1967).

Translated from Astrofizika, 3: 397-409(1967).

Certain parameters of the atmospheres of two F stars (41 Cyg and ν Her) are estimated using the method of growth curves and the Unsöld theoretical growth curve. It is found that the excitation temperatures depend on the excitation potential, but the microturbulence velocity is constant. The ionization temperatures, the electron pressures, and the relative abundances are determined. The abundances are nearly the same as for the Sun. (auth)

32078 TIME-DEPENDENT DIFFUSION OF RADIATION IN AN INHOMOGENEOUS MEDIUM. Minin, I. N. (Leningrad State Univ.). Astrophysics (Engl. Transl.), 3: 154-5(Fall 1967).

Translated from Astrofizika, 3: 345-50(1967).

A method is proposed for solving problems on time-dependent diffusion of radiation in an inhomogeneous stationary medium. Diffuse reflection of light is taken as an illustration of the application of the method. (auth)

32079 SPECTROPHOTOMETRIC STUDY OF βCrB. Chumak, Z. N. (Astrophysical Inst., Alma-Ata, USSR). Astrophysics (Engl. Transl.), 3: 156-9(Fall 1967).

Translated from Astrofizika, 3: 351-7(1967).

The velocity of microturbulence in the atmosphere, the ionization and excitation temperatures, and the logarithm of electron pressure are determined. The excitation temperature and the microturbulence velocity are found as functions of the excitation energy, and the abundances of Fe, Te, Cr, Ca, V, and Sc are established. (auth)

32080 VARIABILITY OF THE ENVELOPE OF THE WOLF-RAYET ECLIPSING BINARY CQ CEPHEI = HD 214419. Guseinzade, A. A. Astrophysics (Engl. Transl.), 3: 160-4(Fall 1967).

Translated from Astrofizika, 3: 359-65(1967).

The photoelectric light curve that was obtained for CQ Cephei is a photometric three-color system close to UBV, using the 20-cm telescope at the Crimean Astrophysical Observatory. Comparison of the results with the data of other observers established (1) the presence of a variation in the width and depth of minima, (2) a difference in the maximum brightness and maximum amplitude of irregular brightness variations, and (3) a variation of color with phase. These quantities vary in different ways in different parts of the spectrum. It is concluded that the envelope of the components is subject to a variation. (auth)

32081 ANALYSIS OF THE HYDROGEN LINES OF THE PECULIAR STARS α^2 CVn AND γ Lyr. Glagolevskii, Yu. V.; Kozlova, K. I. (Astrophysical Inst., Alma-Ata, USSR). Astrophysics (Engl. Transl.), 3: 165-71(Fall 1967).

Translated from Astrofizika, 3: 367-77(1967).

The hydrogen-line profiles of α^2 CVn and γ Lyr, the equivalent widths (W_λ), and the electron densities (lg n_e) are reported. The hydrogen-line profiles of peculiar stars are narrower than those of the comparison stars α Peg and θ Aql. The functions $T(\tau)$ for α^2 CVn and γ Lyr calculated from the H_γ profile are different from the corresponding functions for the comparison stars. (auth)

32082 SPECTROSCOPIC STUDY OF P CYGNI. Luud, L. S. (Inst. of Physics and Astronomy, Tartu). Astrophysics (Engl. Transl.), 3: 172-84(Fall 1967).

Translated from Astrofizika, 3: 379-96(1967).

An approximate analysis is used to show that the ionization temperature in the atmosphere of P Cygni is about 21,000°. It is also found that the Balmer decrement is in good agreement with that calculated by Boyarchuk. The chemical composition of P Cygni is the same as that of class B supergiants. (auth)

32083 POLYCHROMATIC SCATTERING IN A ONE-DIMENSIONAL MEDIUM. Engibaryan, N. B. (Inst. of Mathematics and Mechanics, Erevan). Astrophysics (Engl. Transl.), 3: 145-7(Fall 1967).

Translated from Astrofizika, 3: 325-30(1967).

Polychromatic scattering of light in a medium consisting of atoms with three energy levels is discussed. The transfer equations are integrated in two special cases. (auth)

32084 POSSIBLE UNSTABLE OSCILLATIONS OF A NEUTRON STAR. Vandakurov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 9: 76-9 (Jan. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 133-6(Jan. 20, 1969).

It is known that the criterion of conductive instability is written in the form $\rho'/\rho - p'/\gamma p \leq 0$, where $\gamma(p,\rho)$ determines the relation between the Lagrangian components of the pressure and density perturbations: $\delta p/p = \gamma\delta\rho/\rho$, and the prime denotes the derivative with respect to the radius γ. For the case of small radiation pressure and total ionization, $\gamma = 5/3$. A superdense body (neutron star) is considered, for which the pressure is a function of the density only, and the time of establishment of chemical-composition equilibrium is much shorter than the period of the oscillations. (W.D.M.)

32085 ASYMPTOTIC FORMULAS FOR THE X AND Y FUNCTIONS IN THE THEORY OF MULTIPLE SCATTERING OF RADIATION WITHIN A LINE. Nagirner, D. I. Astrophysics (Engl. Transl.), 3: 133-9(Fall 1967).

Translated from Astrofizika, 3: 293-310(1967).

The scattering of resonance radiation in a plane-parallel layer of large optical thickness τ_0 is investigated. It is assumed that pure scattering takes place with complete frequency redistribution. An analysis is given of the Doppler profile of the absorption coefficient and of a profile which falls toward the wing in proportion to a power of the frequency. Asymptotic formulas covering all values of the argument z are derived for the functions $X(z,\tau_0)$ and $Y(z,\tau_0)$. The intensity of escaping radiation can frequently be expressed in terms of these functions for $\tau_0 \gg 1$. A number of line profiles are constructed as examples of the application of these asymptotic formulas. Asymptotic expressions are also derived for the mean number of scatters in a layer. (auth)

32086 SOME NONLINEAR PROBLEMS IN THE THEORY OF RADIATION TRANSFER WITHIN SPECTRAL LINES. Terebizh, V. Yu. Astrophysics (Engl. Transl.), 3: 129-32(Fall 1967).

Translated from Astrofizika, 3: 281-91(1967).

Diffusion of radiation in a plane-parallel isothermal gas layer

consisting of two- or three-level atoms is discussed (in the three-level case the 1 — 2 transitions are forbidden). Stimulated emission and frequency redistribution of quanta on scattering are taken into account. The Ambartsumyan method of self-consistent optical depths is used to reduce the problem to the solution of linear integral equations and to determine the true optical depths in the centers of lines from the relationships connecting the X and Y functions or their moments. (auth)

32087 AN INVESTIGATION OF CERTAIN ASPECTS OF THE DYNAMICAL STABILITY OF STARS. van der Borght, R. Bull. Cl. Sci., Acad. Roy. Belg., 54: 1207-13(1968).

The effect of a variable ratio of specific heats on the dynamical instability of a pre-main-sequence star was investigated. A discussion of the dynamical instability of polytropes is also included. (auth)

32088 THEORETICAL CONTINUOUS AND LINE SPECTRA OF STARS IN A CLOSE BINARY SYSTEM. Buerger, Paul Francis. Columbus, Ohio, Ohio State Univ., 1968. 89p.

Thesis.

Models have been constructed for rotationally and tidally distorted stars as they appear in synchronous, circular orbits in close binary stars. The continuous radiation emitted in the direction of the observer is computed at several wavelengths. The equivalent width of an absorption line superposed on the gray atmosphere is computed. The effects included are limb-darkening, shape distortion, variation of the effective temperature over the surface of the star, angle of inclination, and orbital phase. Hydrostatic equilibrium is assumed throughout. Large variations of the continuous radiation at ultraviolet wavelengths are expected as functions of the separation and the orbital phase. For very close systems, the continuous radiation shows significant variation with angle of inclination such that the system always appears fainter when viewed equator-on than when viewed pole-on. This apparently leads to a resolution of a previously found discordance between observation and theory for the "reflected" light of Algol-type systems. For absorption lines with strong temperature dependence, quite large variations of the equivalent width as functions of the separation and the orbital phase are expected. Variations with phase should show a decrease in line strength as the star is eclipsed. An extremum in the equivalent width of the line should occur at one-half phase. (Diss. Abstr.)

32089 CONVECTIVE ENERGY TRANSPORT IN STELLAR ATMOSPHERES. Ulrich, Roger Keith. Berkeley, Calif., Univ. of California, 1968. 121p.

Thesis.

The problem of convective energy transport in realistic model stellar atmospheres is considered. Allowance is made for the rapid change of the fundamental physical parameters with depth associated with the onset of hydrogen ionization. Under these conditions the convective flux must be considered a function of the temperature gradient over an extended region. The theoretical approach to this problem has been basically to use a modification of a mixing length theory. In this extended mixing length theory the normally unspecified convective cell has been identified with a meteorological phenomenon known as a convective thermal. This meteorological model provides the necessary information about the strength of coupling between neighboring regions. An iterative series of models has been computed to ensure that the nonlocally determined convective flux together with the radiative flux are constant with depth. Two atmosphere cases are studied in detail: a solar case and a case matching Arcturus. In the solar case a local model and a nonlocal model are computed which fit the solar interior P—T relation. A corresponding pair for Arcturus shows that there is little effect on evolutionary tracks from the nonlocal calculation. The temperature profile just below the photosphere in the nonlocal calculation is quite different from the profile determined with the local calculation. An approximate treatment of the overshoot from the unstable region into the stable upper atmosphere is provided. (Diss. Abstr.)

32090 STARS IN REFLECTION NEBULAE. Racine, Joseph Albert Rene. Toronto, Univ. of Toronto, 1967.

Thesis.

A discussion is presented on spectroscopic and photometric observations of stars in reflection nebulae. The program stars were taken from a catalog compiled by Professor S. van den Bergh. The catalog contains all the BD stars which are seen to illuminate reflection nebulae visible on both the blue and the red prints of the Palomar Sky Survey. As a result of the present investigation, photoelectric photometry on the UBV system is now available for essentially all of the 158 stars in the catalog, while 136 also have spectral classification on the MK system. This program adds 79 new classifications to the already available material. The equivalent width of the hydrogen lines and the central depth of the interstellar band at λ4430 were also measured for 93 early type program stars. (TSS) (Diss. Abstr.)

32091 SYNCHRONOUS PHOTOMETRY OF DQ HERCULIS. Nather, R. Edward; Warner, Brian (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc., 143: 145-65(1969).

Photometric measurements of DQ Her, synchronized with the 71.1 s pulsation of the white dwarf component, were made. Synchronous averaging reduces noise due to the rapid light fluctuations in the system and due to seeing variations. This has enabled an accurate mean light curve for the 71.1 s pulsation to be derived. The light curve is sinusoidal to better than 10%. Observations made during eclipses in the system demonstrate that the binary period is increasing linearly with time. This is interpreted as mass loss at a rate $\geq 1.0 \times 10^{-7} M_{\odot}\ yr^{-1}$. Detailed observations of the 71.1 s pulsations at the time of eclipse of the white dwarf component demonstrated that the white dwarf itself does not contribute more than 2 or 3% of the total light in the system. Thus the true amplitude of the pulsations is probably in excess of 1 magnitude. Similarly it is shown that shoulders in the light curve immediately preceding and following eclipse cannot be due to a bright spot on the white dwarf. It is suggested that the nebula surrounding the white dwarf is optically thick, and the resulting eclipse of a bright area in the nebulosity itself is responsible for the shoulders. This suggestion also explains the general variation in amplitude of the 71.1 s pulsations. (auth) (UK)

32092 FREQUENCY DISTRIBUTION OF THE MASSES OF STARS FORMED FROM CLOUDS OF SOLID HYDROGEN GRAINS. Reddish, V. C. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc., 143: 139-44(1969).

The frequency distribution of the masses of stars formed from isothermal clouds of solid hydrogen grains is determined. For a cloud in equilibrium, the number of stars formed per unit range of stellar mass F(M) is well represented by the formula $F(M) \propto M^{-n}$ with n = 1.9. If the cloud is contracting, n is increased to ≈2.1 to ≈2.2. The result is thus in moderately good agreement with the Salpeter Initial Mass Function for which n = 2.35. (auth) (UK)

Quasi-Stellar, Radio, and X-Ray Sources

32093 (D-1-82-782) HIGH ENERGY X-RAYS FROM CYGNUS XR-1. Bingham, R. G.; Clark, C. D. (Boeing Scientific Research Labs., Seattle, Wash. Geoastrophysics Lab.). Dec. 1968. 27p. Dep.

Celestial x rays (20 to 130 keV) from Cyg XR-1 were detected during a high-altitude balloon flight on May 3, 1967 from Palestine, Texas. The photon flux in the energy range 20.0 to 30.9 keV corrected to the top of the atmosphere is 0.0200 ± 0.0031 photons $cm^{-2}\ sec^{-1}\ keV^{-1}$, which confirms a recently reported high x-ray intensity from Cyg XR-1 during May 1967 (Overbeck et al., 1968). The results are consistent with a continuum energy spectrum given by $60.0\ E^{-2.60 \pm \frac{0.09}{0.08}}$ photons $cm^{-2}\ sec^{-1}\ keV^{-1}$. It is found, moreover, that the measurements are equally compatible with either a black body at 1.2×10^{8}°K or a hot, thin plasma at 3.5×10^{8}°K. Comparison of the measurements with observations of other experimenters indicates the spectrum of Cyg XR-1 is probably not just a simple power law or exponential function; however, a black-body curve can be excluded. (auth)

32094 PULSAR MODEL. Vladimirskii, V. V. JETP Lett. (USSR) (Engl. Transl.), 9: 116-18(Feb. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 199-200(Feb. 5, 1969).

A pulsar model was recently proposed by Hewish, et al. (1968), explaining the periodic variations of the intensity of the radio emission as being due to oscillations of the shape of the star. The frequency of the quadrupole oscillations of an incompressible liquid sphere is given by $\nu^2 = (16\pi/15)\,G\rho$, where G is the gravitational constant and ρ is the density. At densities close to those of white dwarfs, oscillation periods on the order of 1 sec are obtained, which are characteristic of pulsars. Allowance for compressibility does not change the order of magnitude of the frequencies. The main difficulty of such a model is the attenuation of the quadrupole oscillations, which is related to the emission of gravitational waves. The lifetime of the free shape oscillations is less than a day. A rotational—vibrational model is considered which, apparently, can explain the longer lifetime of small deviation of the shape of the star from axial symmetry. (W.D.M.)

Solar Phenomena

32095 COSMIC RAYS AND THE DYNAMICS OF THE SOLAR WIND. II. Dorman, I. V.; Dorman, L. I. (Inst. of Terrestrial

Magnetism, Ionosphere and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 812-17(1968).

Translated from Geomagn. Aeron., 8: 1008-13(1968).

It is demonstrated that the region of the solution of the second-order nonlinear differential equation describing the interaction of galactic cosmic rays with the solar wind breaks down into four regions. An approximate analytical solution is obtained in the first two regions (closest to the Sun) and in the last region (closest to the turbulent layer). A numerical solution is found for the third region. The variation in wind velocity with distance from the Sun and the distance to the turbulent layer are determined for the solar activity maximum and minimum. (auth)

32096 CHARACTER OF THE INTERPLANETARY MEDIUM DURING DECREASING SOLAR ACTIVITY (SEPTEMBER–OCTOBER 1962), ACCORDING TO MARINER 2 DATA. Kovalevskii, L. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 803-6(1968).

Translated from Geomagn. Aeron., 8: 988-1002(1968).

The following parameters of the interplanetary medium at distances of ~0.8 to 1 AU are analyzed for a period of decreasing solar activity on the basis of Mariner 2 data: the dynamic, static, and magnetic pressures, and the ratio of the energy density of directional motion to the energy density of the magnetic field. It is demonstrated that these parameters vary substantially. The boundaries of the region of joint rotation of the medium with the Sun and of the interplanetary cavity are determined. (auth)

32097 DEFORMATION AS THE REASON FOR LARGE-SCALE MAGNETIC FIELD VARIATIONS IN INTERPLANETARY PLASMA FLOWS. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 887-9(1968).

Translated from Geomagn. Aeron., 8: 1098-9(1968).

Computation of nonstationary three-dimensional plasma flows is extremely complicated and is far from being completed, even in the hydrodynamic approximation. Therefore, various approximate estimates must be used that illustrate some particular situation to analyze the observed variations. Some arguments in favor of deformation (compression and expansion) as the cause of large-scale magnetic-field variations in interplanetary plasma flow are presented here. (W.D.M.)

32098 ACCELERATION OF CHARGED PARTICLES IN INTERPLANETARY SPACE. Yukhimuk, A. K.; Kats, M. E. (Inst. of Geophysics, Kiev). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 889-91(1968).

Translated from Geomagn. Aeron., 8: 1100-1(1968).

Much attention has been directed to the problem of particle acceleration in interplanetary space. The hypotheses advanced on particle acceleration involve the annihilation of magnetic fields, Langmuir oscillations, large-scale hydromagnetic turbulence, and Alfvén oscillations. This note examines the change in the energy of charged particles resulting from fluctuations in a turbulent plasma. (W.D.M.)

32099 OBSERVATIONS OF SUNSPOTS IN 1966. Balli, E. (Univ., Istanbul). Istanbul Univ. Fen. Fak. Mecm., Seri C, 32: 65-75(Jan.-Oct. 1967). (In French).

The regular observation of sunspots was carried out in 1966 at the University of Istanbul. The observation consists in tracing the visible spots and faculae on the projected image of the solar disk. On the sketches thus obtained, the heliographic coordinates of each group are obtained. Several statistical results concerning sunspots are given. (tr-auth)

32100 THEORETICAL STUDIES OF THE SOLAR WIND PHENOMENON. Parker, E. N. (Univ. of Chicago). Space Sci. Rev., 9: 325-60(May 1969).

A review is presented of current theoretical topics concerning the solar wind. Broadly speaking the questions outstanding at the present time concern the loss of angular momentum to the Sun, the origin of the fluctuations observed in the wind at the orbit of Earth, conditions in the wind in regions yet unvisited by spacecraft (inside the orbit of Venus, beyond the orbit of Mars, and out of the plane of the ecliptic), conditions at the terminus of the wind, etc. The question of angular momentum loss is important in understanding the evolution of the Sun to its present form with a slowly rotating surface. Evidence from both comet and spacecraft observations of the wind indicate that the rate at which angular momentum is being carried away by the solar wind is very large, of the order of 10^{31} dyne/cm in the gas flow and half as much by the interplanetary magnetic field. But theory cannot account for more than about 10^{30} dynes/cm in the gas without special assumptions. The fluctuations presently observed in the wind at the orbit of Earth have scales ranging upward from 10^2 km. Their presence is puzzling because fluctuations with scales less than about 10^6 km are not expected to survive from the Sun. Presumably, therefore, the fluctuations are generated by the velocity differences of more than 100 km/sec in the wind from different regions in the solar corona and by instabilities produced by the anisotropy of the electrons of the wind plasma. Conditions in the wind at places far removed from the orbit of Earth can be inferred from the behavior of cosmic rays. The evidence is that the wind becomes relatively placid beyond about 5 AU, extending from there out to 30 to 300 AU without much small-scale turbulence. There are also some suggestions that the wind may perhaps be less turbulent toward the Sun from 1 AU, and that the wind may be faster and more turbulent at higher solar latitudes. But the ambiguity of the situation does not permit a firm conclusion on this yet. (auth)

32101 THE VECTOR MAGNETOGRAPH OF THE FRAUNHOFER INSTITUT. Deubner, Franz-Ludwig; Liedler, R. (Fraunhofer Institut, Freiburg i. B.). Solar Phys., 7: 87-121 (Apr. 1969).

A new vectormagnetograph is described that measures all components of the magnetic field vector strictly simultaneously. The azimuth of the direction of the field is continuously obtained during the observation by means of a servo circuit. As a first step of data recording a photographic method is applied which presents all 5 quantities (longitudinal and transverse component of the field vector, azimuth, Doppler shift, and intensity) in the form of maps. Several methods of calibration are discussed in detail. For stronger fields the calibration turns out to be particularly difficult. The sensitivity obtained is 4 gauss using a scanning spot of 3″ × 3″ and a time constant of 1 sec. This value agrees with the shot-noise of the multipliers which can be inferred by taking the light transmittance of the whole instrument into consideration. Transverse fields have been measured with a sensitivity of 130 gauss (300 gauss, if the random deviation of the azimuth is <10°). In this case the scanning spot covered 5″ × 5″, the time constant being 3 sec. A series of vectormagnetograms is presented which were obtained during a 2B-flare event in a center of activity. The field configuration is discussed with regard to the position of the flare. (auth)

32102 A QUANTITATIVE TREATMENT OF SOLAR 'SEEING.' I. Coulman, C. E. (CSIRO, Sydney). Solar Phys., 7: 122-43 (Apr. 1969).

Measurements of temperature-fluctuation statistics in a locally homogeneous, isotropic turbulent atmosphere above level land are shown to enable the quality of telescopic images of celestial objects to be calculated. Data obtained with captive-balloon-borne apparatus are used, together with other existing data, to calculate the modulation transfer function and Strehl Definition for both long- and short-exposure images formed by typical solar telescopes operating under a variety of meteorological conditions. The size of telescope may thus be matched to the expected atmospheric conditions; the improvement in performance and utilization of the instrument, obtainable by raising it on a tower, may be calculated. An 11-cm aperture telescope, for example, is shown to be atmosphere-limited for long exposures in average daytime conditions; raising it from 2 to to 30 m above the ground makes an almost threefold improvement in definition. If observations are confined to intervals of good "seeing" the full resolution of such a telescope may be realized. The existence of such intervals is attributed to convective thermal structure in the atmosphere and observational statistics of periods of below-average temperature fluctuation are given for a range of general meteorological conditions. (auth)

32103 SOLAR ROTATION, 1966-68. Livingston, W. C. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 7: 144-6(Apr. 1969).

A modest program of measuring the rotation of the Sun by means of the Doppler compensator of the solar magnetograph began in 1966. The observations are taken twice a year around the time when the position angle P of the Sun's rotational pole is zero and B_0, the meridional tilt of the pole, is a minimum. Data obtained at these times are simple to reduce to angular velocity. The aim is to measure solar rotation as a function of latitude, height in the Sun's atmosphere and, eventually, over the Solar cycle. Height discrimination is obtained by comparing the chromospheric line Hα with the photospheric lines Fe 5250 and Fe 5233. Results for three years are given. (W.D.M.)

32104 SOLAR ACTIVITY AND THE 11-YEAR MODULATION OF COSMIC RAYS. Balasubrahmanyan, V. K. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 7: 39-45(Apr. 1969).

The cosmic-ray intensity during the 18th and 19th solar cycles is examined in the light of Gnevyshev's suggestion of the presence of two maxima in each solar cycle. The 18th solar cycle (1944–

54) has two prominent and widely separated cosmic-ray minima corresponding in phase with the two maxima in Bartel's A_p index. For the 19th solar cycle the existence of two minima is less prominent than for the 18th solar cycle. The maximum at higher solar latitudes is more effective in reducing cosmic-ray intensity than the maximum at the lower latitudes. A_p, however, has a larger maximum during the lower latitude solar maximum. A relation between A_p and cosmic-ray intensity is obtained. This relationship is shown to be consistent with Parker's solar-wind theory of the modulation of cosmic rays. (auth)

32105 CONVERGENT SOLUTIONS OF THE INVISCID SOLAR WIND EQUATIONS. Eisler, Thomas J. (Catholic Univ. of America, Washington, D. C.). Solar Phys., 7: 46-8(Apr. 1969).

Formal solutions of the inviscid solar-wind equations as power series in the inverse one-seventh power and in the inverse one-fifth power of the distance from the Sun are shown to be convergent. (auth)

32106 ASYMPTOTIC SOLUTIONS OF THE VISCOUS SOLAR WIND EQUATIONS. Eisler, Thomas J. (Catholic Univ. of America, Washington, D. C.). Solar Phys., 7: 49-53(Apr. 1969).

There is one and only one solution of the viscous solar wind equations which is asymptotically represented for large distances from the Sun by a formal solution of Whang, Liu, and Chang as a power series in the inverse one-third power of the distance. (auth)

32107 DIRECTIONAL DISCONTINUITIES IN THE INTERPLANETARY MAGNETIC FIELD. Burlaga, Leonard F. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 7: 54-71(Apr. 1969).

It is shown that the interplanetary magnetic field has different characteristics on different scales, and it is noted that a given physical theory may not be applicable or relevant on all scales. Four scales are defined in terms of time intervals on which the data may be viewed. Many discontinuities in the magnetic-field direction are seen on the mesoscale (≈4 days, ≈1 AU). The characteristics of such directional discontinuities which were observed by Pioneer 6 during the period December 16, 1965–January 4, 1966 are presented, with special emphasis on their distribution in time. Previously, it was suggested that such discontinuities are simply boundaries of spaghetti-like filaments extending from the Sun to the Earth. Here it is shown that on the mesoscale unique filaments with sharp boundaries containing well-ordered magnetic fields are not always seen although discontinuities are always present at ≈1 AU. Thus, the interplanetary medium appears to be discontinuous rather than filamentary. The filamentary model implies that discontinuities originate at the Sun and are convected with the solar wind. The discontinuous model allows the additional possibility that the discontinuities form in the interplanetary medium far from the Sun. (auth)

32108 LARGE VELOCITY DISCONTINUTIES IN THE SOLAR WIND. Burlaga, Leonard F. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 7: 72-86(Apr. 1969).

In the course of 3000 hours observation of the interplanetary plasma, the plasma and magnetic-field experiments on Explorer 34 have detected 11 discontinuous solar-wind speed changes, not associated with shocks, of more than 60 km/sec in less than 3 min. These events, called uD's, may show a velocity change of either sign, but the plasma density and temperature are not found to change appreciably across them. Each speed discontinuity occurs simultaneously with a directional discontinuity in the magnetic field. High-resolution magnetic-field data show that sometimes the directional changes occur as rotational fans, and at other times they are erratic or occur within the time resolution of the magnetic-field experiment, 2.6 sec. The flow direction of the solar wind changed at 2 of the 11 uD's. The quiet nature of the field and plasma on each side of these events gives the impression that they are stable. The existence of these uD's is shown to be consistent with the theory of the Helmholtz instability. In particular, the additional observation that the magnetic-field direction change, ω, at a uD tends to be near 90° is consistent with the theory, for uD's with small ω may become unstable as they move from the Sun. (auth)

32109 SOURCE FUNCTIONS OF INFRARED FRAUNHOFER LINES FROM EQUIVALENT WIDTHS. Altrock, Richard C. (Sacramento Peak Observatory, Sunspot, N. M.). Solar Phys., 7: 3-10(Apr. 1969).

A method for obtaining the source function and value of $r_\theta \equiv \kappa_e/\kappa_{L,\theta}$ from the variation of equivalent width across the solar disk was applied to several infrared Fraunhofer lines. The results indicate that most of the lines investigated have non-L.T.E. source functions which are less than or equal to the mean continuum intensity. DeJager and Neven (1968) appear to have underestimated the departures from L.T.E. in a number of cases. (auth)

32110 FORBIDDEN LINES OF Ca II IN THE PHOTOSPHERIC SPECTRUM. Lambert, D. L. (Mount Wilson and Palomar Observatories, Pasadena, Calif.); Mallia, E. A.; Warner, B. Solar Phys., 7: 11-16(Apr. 1969).

On scans obtained with the Oxford photoelectric spectrometer, the CaII transition $4s^2S_{\frac{1}{2}}-3d^2D_{\frac{3}{2}}$ is identified with a weak Fraunhofer line. It is argued that the strength of the line is consistent with the abundance of calcium derived from the permitted lines of Ca I and Ca II. (auth)

32111 MOLECULES IN THE SOLAR PHOTOSPHERE. Pande, M. C.; Gaur, V. P.; Tripathi, B. M. (Uttar Pradesh State Observatory, Naini Tal, India). Solar Phys., 7: 17-21(Apr. 1969).

A consideration of the dissociation equilibrium of diatomic molecules in the Utrecht Reference Photosphere leads to the conclusion that SH, SiO, CS, HF, and HCl may show up in enough concentrations in the solar atmosphere. The number of these molecules above the photosphere is comparable with or more than that of MgH. (auth)

32112 THE INTENSITY, VELOCITY, AND MAGNETIC STRUCTURE OF A SUNSPOT REGION. III. ON THE ORIGIN OF THE APPARENT π COMPONENT IN SUNSPOT UMBRAE. Beckers, J. M. (Sacramento Peak Observatory, Sunspot, N. Mex.); Schroeter, E. H. Solar Phys., 7: 22-5(Apr. 1969).

In order to study the effect of saturation on the shape of the line profile of a normal Zeeman triplet, the line profile for circular polarized light for various absorption coefficients in the line center and various inclinations of the field vector to the line of sight were computed with Unno's theory. (W.D.M)

32113 THE FINE STRUCTURE OF MAGNETIC FIELDS IN SUNSPOTS AND THE DEPENDENCE OF THE MAGNETIC FIELD ON THE SPOT AREA. Kopecky, M. (Astronomical Inst., Ondrejov, Czech.). Solar Phys., 7: 26-7(Apr. 1969).

An equation is given that expresses the relation between the magnetic-field strength H_0 in the center of a spot and the spot area A. H_0 increases with A, first rapidly and then slowly, and asymptotically approaches the value of H_1(small areas of high field strength). Thus, the variation of the equation is qualitatively concurrent with the variation of the dependence of H_0 on A, as determined from observations. (W.D.M.)

32114 SOLAR ACTIVITY AND RECURRENCES IN MAGNETIC-FIELD DISTRIBUTION. Bumba, V.; Howard, R. (Astronomical Inst., Ondrejov, Czech.). Solar Phys., 7: 28-38(Apr. 1969).

A study of the Mount Wilson magnetic-field synoptic chart material divided into latitude zones for the interval 1959–67, and a comparison of the data with sunspot groups have provided a better understanding of the structure of the background-field pattern and its relation to activity. The interaction of old and new fields within the pattern seems to result in long-lived sections of alternating polarity in both hemispheres. Subsurface sources with rotation periods of about 27 days are postulated, which produce active regions over a longitude zone of some tens of degrees. There is a tendency for the background-field features with strong fields to resist to some extent the shearing effects of differential rotation. A prediction is made concerning the nature of the interplanetary magnetic field above the ecliptic. (auth)

32115 STRUCTURES OF SUNSPOTS. Bruzek, Anton (Fraunhofer Institut, Freiburg i. B.). Umsch. Wiss. Tech., 69: 212-13(Mar. 27, 1969). (In German).

By observing H_α photographs of sunspots, an extended fibrous structure could be identified from which aspects of flow or lines of force could be projected. From this, dynamic processes in the chromosphere of the Sun could be postulated. (tr-auth)

Galaxies

32116 ASTRONOMIYA 1966. KINEMATIKA I DINAMIKA ZVEZDNYKH SISTEM. (Astronomy 1966. Kinematics and Dynamics of Stellar Systems). Itogi Nauki, Seriya Astronomiya. Moscow, Viniti, 1968. 200p.

A review is given on the dynamics of stellar systems based on published data covering the years from 1957 to 1966 and part of 1967. The six articles include data on dynamics of spherical stellar systems, dynamics of rotational stellar systems, problems of the third integral of motion in stellar dynamics, star orbits in stellar systems, irregular forces in stellar systems, and galactic kinematics. Extensive references are given for each chapter. (R.V.J.)

32117 IRREGULAR GALAXIES OF THE TYPE OF M 82. Tovmasyan, G. M. Astrophysics (Engl. Transl.), 3: 203-4(Fall 1967).

Translated from Astrofizika, 3: 427-30(1967).

The central regions of seven irregular galaxies were investigated with the 40" telescope at Siding Spring in 1965, five of which were taken from Markaryan's list. The method and classification of the central regions of the galaxies were described previously. A list of the galaxies and estimates of the types of their central parts are given. (W.D.M.)

32118 DWARFS IN SOME CLOSE GROUPS OF GALAXIES. Evyagina, E. V. Astrophysics (Engl. Transl.), 3: 194-202(Fall 1967).

Translated from Astrofizika, 3: 411-25(1967).

The distribution is obtained of faint objects with low surface brightness in four close groups of galaxies taken from the Palomar Sky Atlas. It is found that irregular dwarfs exhibit a tendency to concentrate in three of the groups investigated. (auth)

32119 MAGNETOHYDRODYNAMICS OF INTERSTELLAR GAS–DUST MEDIUM. Gidalevich, E. Ya. (Astrophysics Inst., Alma-Ata, USSR). Astrophysics (Engl. Transl.), 3: 148-53(Fall 1967).

Translated from Astrofizika, 3: 331-44(1967).

Some problems in the magnetohydrodynamics of a two-component gas–dust medium are discussed. It is shown that interstellar plasma containing dust particles can be regarded as consisting of a pure gas component and a gas–dust component. The conductivity of the second component is sufficiently high for it to be described by the methods of magnetohydrodynamics. Gas–dust streams and shock waves in a transverse magnetic field are discussed. An attempt is made to explain the fine filamentary structure of some dust nebulas by an axial pinch in the gas–dust plasma. (auth)

32120 DISTRIBUTION IN SPACE OF CLUSTERS OF GALAXIES. Kiang, T. (Dunsink Observatory, Dublin); Saslaw, William C. Mon. Notic. Roy. Astron. Soc., 143: 129-38(1969).

Reasons are given for believing that the spatial distribution of clusters of galaxies based on crude distance estimates can provide some useful information. Serial correlations of counts of these objects in 50 Mpc cells indicate that clustering occurs at least up to a scale of 100 Mpc. The amplitudes of the serial correlation at 50 Mpc and 100 Mpc are at least 0.23 and 0.16, which are respectively about 15 and 9 standard errors away from the null result for a random distribution. Counts in 100 and 200 Mpc cells faintly suggest clustering over even greater distances. These observations may give insight into the conditions when structure formed in the Universe. (auth)

32121 DYNAMICAL RELAXATION IN GALAXY FORMATION. Smith, Bruce Frederick. College Park, Md., Univ. of Maryland, 1968. 65p.

Thesis.

The observed regularity in the luminosity distributions of spherical and elliptical galaxies suggests that a relaxation mechanism has been important in the dynamical evolution of these systems. The relaxation times based on star–star encounter theory are much longer than the ages of these galaxies. The initial evolution of a galaxy condensing out of the Universe is studied by numerical methods to investigate a possible relaxation effect in the early stages of evolution. It is assumed that star formation is rapid and the system is composed entirely of collisionless stars. The galaxy is divided up into a series of mass shells and the motions of these shells are followed in the evolution. The modeling technique simulates the motion of the stars in the rapidly varying gravitational field of the contracting galaxy. Spherical models and nonspherical models with axial symmetry are investigated. The numerical integration method is shown to be accurate and stable by testing the reversibility of the solution. All models studied reached equilibrium in a few dynamical periods. The evolution of three spherical models, with a range of initial conditions, is followed, and the final density distributions are similar. The initial dynamical mixing leads to a relaxation effect for the models studied. The expected luminosity distributions for these models are compared with observations and are shown to represent systems of moderate central concentration. The luminosity distributions for the computed models are not as centrally condensed as prescribed by de Vaucouleurs' law for the luminosity distribution in elliptical galaxies. The computed models are more centrally condensed than the dwarf elliptical systems. For the nonspherical models, the results indicate the same type of mixing process. The results for one set of initial conditions are compared with an observation of an elliptical galaxy and there is general agreement with the observed luminosity distribution. The results for the nonspherical models indicate a correlation of the equilibrium density distribution with the amount of angular momentum initially given to the system. (Diss. Abstr.)

32122 BLUE CONDENSATIONS ASSOCIATED WITH GALAXIES. Stockton, Alan Norman. Tucson, Ariz., Univ. of Arizona, 1968. 124p.

Thesis.

A number of elliptical and SO galaxies having nearby blue condensations have been listed by Ambartsumyan and Shachbazyan. Two of these galaxies, NGC 3561 and IC 1182, have visible bridges or jets connecting to the associated blue condensations, and these galaxies have been the ones most intensively studied in the present investigation. Several other systems similar to those listed by Ambartsumyan and Shachbazyan have been found in a search of the National Geographic–Palomar Observatory Sky Survey plates covering some 1300 square degrees. Spectroscopic observations were made of some of these blue knots and the galaxies with which they are associated as well as of certain nearby blue galaxies. Estimates of the electron density were made for several of the objects on the basis of the relative strengths of the [O II] λλ3726, 3729 lines. Densities are typically a few hundred cm^{-3} or lower, similar to those found in diffuse nebulae. Calibrated spectrophotometric plates were obtained for three objects: the bright blue condensation near NGC 3561, the blue galaxy Haro 4, and a bright knot in a spiral arm. The continua and the emission-line spectra of the three objects are quite similar, except that Haro 4 has a slightly higher level of ionization than the others. The spectral-energy distributions for the three objects are approximately proportional to λ^{-4}. The continua apparently cannot be interpreted as synchrotron radiation or as free–bound, free–free, or two quantum emission from hydrogen. The most likely explanation for the continuum radiation is that it is of stellar origin, in which case almost all of the light must come from O and B stars. The dimensions of the blue condensations near NGC 3561 and IC 1182 are in the range of 2 to 3 kpc, and their absolute magnitudes are −16 to −17. The linear alignment of the condensations in the NGC 3561 and IC 1182 systems probably sets an upper limit to their ages of a few times 10^8 years. This fact, taken together with the evidence for a large number of young stars, implies that these condensations are recently formed dwarf galaxies. (Diss. Abstr.)

32123 SCHROEDINGER OPERATOR CRITERION FOR THE STABILITY OF GALAXIES AND GAS SPHERES. Lynden-Bell, D.; Sanitt, N. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc., 143: 167-87(1969).

A direct proof is given showing that a stellar system is stable whenever the corresponding barotropic gaseous system is secularly stable. The condition is formulated in terms of a Schrödinger equation. It is shown that a large class of spherical steady-state stellar systems is stable to all nonspherical modes of vibration. For spherical modes the Schrödinger operator method is necessary and sufficient for the stability of barotropic spheres, but for stellar systems, though correct, it is not a very powerful method of proving stability. Antonov's method is harder to apply but more powerful. The Schrödinger method is applied to some model clusters. More general and more powerful methods are needed in this field. (auth) (UK)

Cosmology

Refer also to abstract 32830.

32124 GENERALIZED NEWTONIAN THEORY OF GRAVITATION. Saakyan, G. S.; Mnatsakanyan, M. A. Astrophysics (Engl. Transl.), 3: 140-4(Fall 1967).

Translated from Astrofizika, 3: 311-23(1967).

The Newtonian variant of the generalized theory of gravitation (variable $\varkappa$) is discussed. Internal solutions are found for incompressible-fluid configurations. (auth)

32125 DENSITY OF RELICT PARTICLES WITH ZERO REST MASS IN THE UNIVERSE. Shvartsman, V. F. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 9: 184-6(Mar. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 315-17(Mar. 5, 1969).

An upper limit on the density of difficult-to-observe particles with zero rest mass in the universe was obtained for the case of the Friedmann model. The limit applies to muonic neutrinos and antineutrinos, gravitations, and still-unknown ultra-weakly interacting particles left from the superdense phase. (L.B.S.)

32126 GREEN'S FUNCTIONS IN A DE SITTER UNIVERSE. Geheniau, J.; Schomblond, Ch. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 54: 1147-57(1968). (In French).

Simple expressions are obtained for the Green's functions of the Dâlembertian, the Klein–Gordon, the Weyl, and the Dirac equations in de Sitter space (4-1). The Dâlembertian case is straight-

forward. For the spin-½ massless particle the problem is reduced to the same in Minkowski space. For the other cases, hypergeometric functions appear in the formulae. The Green's functions of the Dirac equation are given only when the second point is at the origin of the coordinate system. (auth)

32127 EVOLUTION OF COSMOLOGICAL MODEL WITH ROTATION. Ruzmaikina, T. V.; Ruzmaikin, A. A. Zh. Eksp. Teor. Fiz., 56: 1742-7(May 1969). (In Russian).

Nonstationary anisotropy of a cosmological model with rotation is considered. It is strongly anisotropic at early stages and gradually evolves toward the isotropic Friedman model. The angular dependence of anisotropy of relict radiation at later stages of evolution of the model is determined. (auth)

Atomic and Molecular Physics

Refer also to abstract 32777.

32128 DESIGN AND OPERATION OF AN ATOMIC HYDROGEN TARGET FOR PRECISION SCATTERING CROSS SECTION MEASUREMENTS. Bayfield, James E. (Yale Univ., New Haven). Rev. Sci. Instrum., 40: 869-74(July 1969).

A new design for a hydrogen atom target is described. An H_2 dissociation of 96 ± 4% is obtained for pressures near 3×10^{-5} Torr and temperatures of about 2400 K. The scattering cell proper is uniformly heated by radiation from a separate resistance heater element. Magnetic field effects are eliminated by gating the 700-A heater current out of phase with the incident particle beam. A method for absolute measurement of the dissociation fraction is described. Target impurities other than H_2 are estimated to be less than 0.2%. (auth)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 31582 and 32559.

32129 PATH OF ELECTRONS IN MATTER. Verdier, Pierre; Arnal, Floreal (CNRS, Toulouse). Compt. Rend., Ser. B, 268: 885-8(Mar. 24, 1969). (In French).

Starting from experiments performed in order to find the coefficients of transmission and backscattering from samples bombarded by monokinetic electrons (energies between 50 and 1200 keV), the path of electrons in matter is determined. The relations obtained depend only on the energy of the incident electrons, the atomic number, the atomic mass, and the volumetric mass of the element considered. (tr-auth)

32130 EVIDENCE OF THE PRESENCE OF METASTABLE ATOMS IN A BEAM OF FAST HELIUM ATOMS. Bastien, Francois; Depuydt, Eliane; Viossat, Gerard (CNRS, Val-de-Marne, France). Compt. Rend., Ser. B, 268: 845-8(Mar. 24, 1969). (In French).

An experimental study of the charge-exchange cross section of helium shows that this varies with the method of formation of the neutral beam. This indicates the presence of metastable atoms in the beam (the study was made in the energy region from 20 to 40 keV). (tr-auth)

32131 IONIZATION OF ATOMIC HYDROGEN EXCITED UNDER THE EFFECT OF AN ELECTRIC FIELD. LeDoucen, Roger; Guidini, Joseph (Faculte des Sciences, Rennes, France. CEN-Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 268: 918-21(Mar. 31, 1969). (In French).

The ionization of fast excited hydrogen atoms obtained by the neutralization of accelerated protons passing through various gaseous targets was studied. Excited levels having principle quantum numbers between 9 and 23 were observed. (tr-auth)

32132 RADIATION FROM SURFACE PLASMONS IN ALUMINUM. Buerker, U.; Steinmann, W. (Univ., Munich). Z. Phys., 224: 179-89(1969). (In German).

Unoxidized Al surfaces were irradiated by 50-keV electrons at grazing incidence. Light emission was observed, whose spectrum exhibited a peak at 10.1 eV. The intensity was very sensitive to surface structure, contamination, and angle of incidence of the electrons. The peak shifted towards higher energies with decreasing film thickness. These results indicate that the effect is due to the radiative decay of nonradiative surface plasmons. (auth)

32133 INELASTIC SCATTERING OF SLOW ELECTRONS IN SOLIDS. Bauer, E. (Michelson Lab., China Lake, Calif.). Z. Phys., 224: 19-44(1969).

A theory of the inelastic scattering of slow electrons in solids due to excitation of interband transitions is developed. It is shown that both nondirect and direct transitions occur, which can be described by a generalization of the formalism used in solid-state optics. Experiments with 30- to 200-eV electrons scattered from Si(111) surfaces with well defined surface structures as determined by low-energy electron diffraction confirm the theoretical predictions. They indicate that the inelastic scattering of slow electrons can be understood in terms of the three-dimensional band structure of solids and suggest the use of inelastic low-energy electron scattering as a tool for band structure analysis. (auth)

32134 TEMPERATURE DEPENDENCE OF THE SPUTTERED EJECTION PATTERN FROM Ge [100] SURFACES. Macdonald, R. J. (Australian National Univ., Canberra). Phys. Lett., 29A: 256-7(May 19, 1969).

The temperature dependence of the ejection pattern of sputtered atoms from [100] Ge has been examined. The pattern undergoes a transition from circular to square, indicative of the annealing of surface disorder, at a temperature of 340 ± 5°C. Certain features of the pattern are described qualitatively. (auth)

32135 AN EXPERIMENTAL STUDY OF THE PRODUCTS OF COLLISIONS OF 1-eV ATOMS WITH SURFACES. Callinan, Joseph Patrick. Los Angeles, Univ. of California, 1968. 119p. Thesis.

An experimental system for studying the gaseous products of collisions of intermediate-energy (1 to 10 eV) atoms with surfaces is developed. From the experimental time-of-flight (TOF) data the particle momentum and energy fluxes as well as the mean speed and mean energy of the scattered atoms are computed. The experimental results for the scattering of neutral argon atoms from mica and vacuum-deposited silver surfaces are presented and compared with other experimental results and with theory. The experimental system consists of (1) the UCLA arc-heated nozzle-source molecular beam, which produces a collimated beam of nearly mono-energetic neutral argon atoms having most probable energies in the range of 0.8 to 1.5 eV, (2) a test surface, either mica or vacuum-deposited silver, whose angle relative to the incident molecular-beam and whose temperature can be varied, and (3) the TOF detection system. The data were analyzed using molecular-beam TOF spectroscopy techniques. The fluxes and the average properties of the scattered atoms are expressed in terms of the various moments of the TOF distribution function and the measured signal. A three-parameter TOF distribution function is derived for an assumed two-parameter speed distribution function. The parameters are computed from the moments of the recorded signal and the above properties are calculated. Several experimental conditions were varied; only the type of surface and the molecular-beam incidence angle produced significant changes in the spatial distributions of the computed results. A supraspecular lobe appears in the flux distributions for scattering from mica but not for scattering from silver surfaces. The effect of reducing the angle of incidence from 60° to 0° was the coalescing of multiple lobes into a single lobe oriented in the normal direction. (Disser. Abstr.)

32136 SCATTERING OF ^{3}He, ^{4}He, AND THE HYDROGENIC MOLECULES FROM THE (111) PLANE OF Ag. Palmer, Robert L.; Saltsburg, Howard; Smith, Joe N. Jr. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys., 50: 4661-7(June 1, 1969).

Molecular beams of the isotopes of He and H have been reflected from the (111) plane of epitaxially grown Ag crystals. The spatial scattering distributions of ^{3}He and ^{4}He are compared with those of H_2, HD, and D_2 at various angles of incidence and primary beam temperatures from 80° to 1500°K. Deviations in the specularity of these gases are interpreted in terms of the exchange of rotational state energy of the diatomic species at the surface. Comparisons of number density and flux measurements indicate a significant dependence of the mean speed of the reflected beam on θ_r. It is proposed that this variation is also enhanced by the degree of rotational state interactions, which decreases with increasing beam temperature. Finally, it is suggested that the appearance of a truly specular component in these scattering distributions is related to an apparent surface roughness through the relation $\lambda > h \cos \theta_i$ where 0.8 Å < h < 1.7 Å. (auth)

32137 PREFERENTIAL SCATTERING OF Ar FROM LiF: CORRELATION WITH LATTICE PROPERTIES. Smith, Joe N. Jr.; O'Keefe, D. R.; Saltsburg, Howard; Palmer, R. L. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys., 50: 4667-71 (June 1, 1969).

A study of the scattering of thermal-energy Ar atoms from the (001) plane of LiF is reported. Multiple peaks in the scattered flux distribution are observed. The major peak in the distribu-

tion is the analog of the single-lobe directed scattering distributions observed previously, using metal targets, in terms of its behavior as a function of angle of incidence and beam temperature. However, this major peak in the Ar–LiF data also displays a dependence on the azimuthal angle of the target that may be associated with the anisotropy in the elastic properties of LiF. Other peaks in the Ar distribution are observed to lie in fixed directions along rows of second-nearest-neighbor unlike ions in the LiF lattice. It is suggested that dipole–induced-dipole attractive forces serve to enhance the coupling of the Ar atoms to the longitudinal optical modes of vibration in these directions, giving rise to preferential re-emission. (auth)

32138 STOPPING POWER OF ARGON FOR IONS WITH Z RANGING BETWEEN 3 AND 13. Andreev, V. N.; Nedopekin, V. G.; Rogov, V. I. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1504-7(May 1969). (In Russian).

A multiple ionization chamber was employed for studying the energy dependence of the stopping power of argon for Li, Be, B, C, N, O, Na, and Al ions with energies lying between 0.5 and 2 MeV/amu. The experimental data point to the existence of a universal dependence of $\langle Z^2\rangle/Z^2$ on the parameter $\xi = v/Z\alpha c$ where v is the ion velocity and $\alpha = 1/137$. (auth)

Atomic and Molecular Properties

Refer also to abstracts 32085 and 32086.

32139 TIME-DEPENDENT BEHAVIOR OF THE 10830 A LINE IN A LOW-PRESSURE HELIUM AFTERGLOW. Collins, C. B.; Hurt, W. B. (Southwest Center for Advanced Studies, Dallas). Phys. Rev., 179: 203-9(Mar. 5, 1969).

The time-dependent behavior of the intensity of the 10,830-Å line emitted from a pulsed helium afterglow at 3 torr was investigated with an improved spectrometric system of sufficient sensitivity/bandwidth ratio to resolve the behavior of this line over a 50-msec time interval. A high degree of correlation was observed between the 10,830-Å line intensity and the 4650-Å molecular-band intensity for afterglow times in excess of 2 msec. A recombination of the He_2^+ ion leading to dissociation and having a rate coefficient of 2×10^{-11} cm^3/sec at 10^{12} electrons/cm^3 is consistent with data. (auth)

32140 SHORT-RANGE INTERMOLECULAR FORCES. CALCULATION OF THE H_2–H_2 INTERACTION. Tapia, Orlando; Bessis, Georges; Bratoz, Savo (Centre de Mecanique Ondulatoire Appliquee, Paris). Compt. Rend., Ser. B, 268: 813-16 (Mar. 24, 1969). (In French).

The configurations studied are those that permit an analysis of the Pauli interaction forces between two H_2 molecules placed a short distance from each other. Emphasis is on the following points: the variation of interaction energy as a function of the intermolecular distance, the variation of the interaction energy as a function of the mutual orientation of the two molecules, and the variation of the interaction energy as a function of the distance between two atoms of one of the molecules. (J.F.P.)

32141 NEW RESULTS IN THE STUDY OF THE SPARK SPECTRA OF GADOLINIUM. Blaise, Jean; Van Kleef, Th. A. M. (CNRS, Orsay, France. Zeeman Laboratorium, Amsterdam, Netherlands). Compt. Rend., Ser. B, 268: 792-5(Mar. 17, 1969). (in French).

By use of the Zeeman effect the ten missing levels of the configuration $4f^7(^8S)5d^2$ were identified in the same way as numerous levels belonging to the configurations $4f^86s$, $4f^85d$, $4f^86p$, and $4f^75d6s$. (tr-auth)

32142 SOME NEW ASTON BANDS IN HYDROGEN. Papp, Nicolas; Kerwin, Larkin (Univ. Laval, Quebec). Phys. Rev. Lett., 22: 1343-6(June 23, 1969).

Broad nonintegral mass bands at the 0.66- and 0.75-u mass positions appear in the hydrogen mass spectrum at high pressure (10^{-4} torr). A primary peak is also observed at the 1.5-u mass position. These Aston bands and mass peak may be interpreted as resulting from the creation and collision-induced reactions of the H_3^+ ion, which would be formed in a surface reaction between H_2^+ and adsorbed hydrogen. (auth)

32143 DISCRETE VIBRATIONAL STATES DUE ONLY TO LONG-RANGE FORCES: $^2\Sigma_u^+(2p\sigma_u)$ STATE OF H_2^+. Peek, James M. (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 50: 4595-6(May 15, 1969).

The $^2\Sigma_u^+(2p\sigma_u)$ state of H_2^+ has an attractive potential at large internuclear separations R; there is a minimum in the potential curve at R = 12.55 a_0. Calculation of discrete states for this case indicated the existence of states for v = 0, l = 0, 1, 2, and v = 1, l = 0. These states are rather weakly bound, and unusually large internuclear separations are important. (A.G.W.)

32144 ELECTRONIC STRUCTURE OF URANIUM AND TRANSURANIUM ELEMENTS. Jezowska-Trzebiatowska, Boguslawa. pp 71-82 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968.

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

The results are given of studies of 5f orbitals in chemical compounds. Atomic structure studies were made on the elements thorium through curium. (M.O.W.)

32145 ODD–EVEN ISOTOPE SHIFTS IN THE ATOMIC SPECTRUM OF TIN. Silver, J. D.; Stacey, D. N. (Clarendon Lab., Oxford). Phys. Lett., 29A: 248(May 19, 1969).

Measurements of odd–even isotope shifts in the line λ 3283 Å of the atomic spectrum of tin are reported. These are compared with previous work, and revised values of staggering coefficient are given. (auth)

32146 LOWER BOUND CALCULATION OF AUTOIONIZING STATE IN HELIUM. Wu, Hsien-chueh. Storrs, Conn., Univ. of Connecticut, 1968. 88p.

Thesis.

The lower bounds on the energy levels of autoionizing states are studied. Detailed calculations are made for the autoionizing states of helium. The Stevenson and Crawford formula for the lower bound to the energy levels of bound states is generalized and extended to autoionizing states. The projection operator introduced by Hahn, O'Malley, and Spruch is used in the representation of autoionizing states. A finite truncated subspace of the Q-space, spanned by the eigenfunctions of an independent-particle Hamiltonian H_1, is used as trial space Q_t in terms of which the trial function $Q_t\psi$ is expanded. In the application of the generalization of the Stevenson and Crawford formula, a quantity defined by $\sigma(E) = \langle Q_t\psi|(H-E)^2|Q_t\psi\rangle$ must be calculated, where H is defined by $H = H_1 + (r_{12})^{-1}$ and E is the trial energy such that $Q_tHQ_t\psi = E\psi$. The Stevenson–Crawford formula is derived in terms of σ. After the matrix elements of H and H^2 are computed, then σ and the lower bound, which is shown to be $E - [\sigma(E)]^{1/2}$, can be computed for any given trial function. Lower bounds to the energies of several autoionizing states of ^1P and ^3P symmetry were calculated for a trial function with eight base elements, which are {(2s2p); (2snp), (ns2p), n = 3,4; (2pnd), n = 3,4,5}. The gaps between upper bound and lower bound are found to be 3.314, 0.677, and 1.428 for the first three singlet states, and 2.334, 1.581, and 0.725 for the first three triplet states; all are in eV. (TSS) (Disser. Abstr.)

32147 OSCILLATOR STRENGTHS, *f*, FOR HIGH-LEVEL TRANSITIONS IN HYDROGEN. Menzel, Donald H. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Institition Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 18: Suppl. Ser. 161, 221-46(May 1969).

The calculation of transition probabilities for high-level transitions in hydrogen proceeds easily from a rapidly converging new formula. Two tables of f-values for transitions $n + c \rightarrow n$ cover the following ranges. Table 1: n = 50, . . . , 900; c = 1, 2, . . . , 6. Table 2: n = 1, 2, . . . , 50; c = 1, 2, . . . , 48. Simple asymptotic formulas exist for transitions of large n and small c. The f's obey the sum rule $\Sigma f = 1$, despite the fact that many of the f's are much greater than unity. The paradox is resolved by the necessity of subtracting f-values for downward transitions. (auth)

32148 INFLUENCE OF INTERMOLECULAR ELECTRIC FIELDS ON THE PROBABILITIES OF DIPOLE TRANSITIONS. Grechikhin, L. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 368-9(Nov. 1968).

Translated from Opt. Spektrosk., 25: 655-7(Nov. 1968).

Under the influence of intermolecular electric fields in a plasma, levels with different values of the azimuthal quantum number and levels with different values of the principal quantum number can be intermixed. The intermixing of states with different values of the azimuthal quantum number leads to a reduction in the probability of allowed dipole transitions and to a sharp increase of the probability of forbidden transitions. The intermixing of states with different values of the principal quantum number leads, on the contrary, to an increase of the probability of allowed transitions as long as lines in the spectrum do not disappear. (auth)

32149 HANLE EFFECT IN 2^1P HELIUM. Fry, E. S.; Williams, W. L. (Univ. of Michigan, Ann Arbor). Phys. Rev., 183: 81-90(July 5, 1969).

The oscillator strength for the resonance (1^1S–2^1P) transition in atomic helium has been determined from a measurement of the lifetime of the 2^1P state. This lifetime was obtained using a modi-

fied zero-field level crossing (Hanle) method. The scattering sample was a thermal-velocity beam of 2^1S metastable atoms. Resonant 2-μ (2^1S-2^1P) radiation is absorbed by the 2^1S atoms, which are excited to the 2^1P state. This state then primarily decays to the ground 1^1S state with the emission of resonance (584 Å) radiation. The lifetime of the 2^1P state was determined from measurements of the magnetic-field dependence of the angular distribution of the 584 Å intensity. This new technique eliminates the problem of constructing a vacuum ultraviolet resonance lamp. The measured lifetime τ (2^1P) is $(5.63 \pm 0.22) \times 10^{-10}$ sec. The resulting absorption oscillator strength for the resonance transition is 0.273 ± 0.011. This oscillator strength agrees with the theoretical value. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 32767.

32150 SMALL EFFECTS IN THE THEORY OF MUONIC ATOMS. I. EXACT CALCULATION OF EIGENVALUES FOR ATOMS WITH DEFORMED NUCLEI. McKinley, John M. (Oakland Univ., Rochester, Mich.). Phys. Rev., 183: 106-11(July 5, 1969).

Exact numerical solutions of the coupled Dirac equations for a muon moving in the electrostatic field of a permanently deformed nucleus were obtained and compared with the solutions obtained by the perturbation technique previously employed. Expressions are given for the boundary and continuity conditions upon the exact coupled solutions. For ^{238}U as represented by a reasonable charge distribution, the exact energy eigenvalues were shifted by the following amounts from the perturbation values: 1s binding increased by 7.46 keV, 2p increased by various amounts between 1.94 and 6.91 keV, and 3d increased by less than 1 keV. The effect upon 2p eigenvalues cannot be duplicated by the perturbation technique by merely changing the parameters of the charge distribution. (auth)

32151 ANNIHILATION OF POSITRONS IN ARGON. II. THEORETICAL. Orth, P. H. R.; Jones, G. (Univ. of British Columbia, Vancouver). Phys. Rev., 183: 16-22(July 5, 1969).

The results of measurements of the electric-field dependence of the direct annihilation rate of positrons in argon are used to test the validity of simple models representing the interaction between a positron and an argon atom. Despite the fact that such models yield results in agreement with electron-scattering data, they are inadequate in the case of positrons. By comparing these data with recent measurements of the temperature dependence of the lifetime of positrons in argon, a value of $(33 \pm 5)\pi a_0^2$ is obtained for the scattering cross section of thermal positrons in argon. (auth)

32152 ANNIHILATION OF POSITRONS IN ARGON. I. EXPERIMENTAL. Orth, P. H. R.; Jones, G. (Univ. of British Columbia, Vancouver). Phys. Rev., 183: 7-15(July 5, 1969).

The annihilation of positrons in argon has been investigated as a function both of argon density and applied electric field. The direct annihilation rate decreases with increasing field as observed in earlier work. These electric-field results are compared with simple theoretical models of the positron–argon atom interaction in the following paper: A small nonlinear dependence on density of the direct annihilation rate became apparent at densities larger than about 10 amagats. The linear portion of the direct rate was characterized by $Z_{eff} = 27.3 \pm 1.3$. From the density dependence of the orthopositronium lifetime, the free orthopositronium annihilation rate (λ_1) and linear quenching rate in argon (λ_q) were found to be $\lambda_1 = (7.53 \pm 0.18) \times 10^6$ sec^{-1}, and $\lambda_q = (0.24 \pm 0.02) \times 10^6$ sec^{-1} amagat^{-1}. The role of impurities in these measurements is also discussed. (auth)

Collision Phenomena

Refer also to abstracts 32130, 32592, and 32857.

32153 (CEA-Bib-144) BIBLIOGRAPHIC STUDY OF THE AVERAGE ENERGY LOST BY ELECTRONS TO FORM AN ION-PAIR IN AIR. Bertel, Evelyne (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1969. 10p. (In French). Dep.

A critical study of the most important experimental works on the average energy lost to produce one ion pair in air is made to find the best methods used. Experimental results used to determine the value adopted by the I.C.R.U. in 1964 and used at the present time are noted. The 17 references give the most important works available in the literature. (auth)

32154 (CEA-R-3695) STUDY OF TOTAL IONIZATION BY α PARTICLES, IN PURE GASES AND GASEOUS MIXTURES CONTAINING METASTABLE ATOMS, AS A FUNCTION OF TEMPERATURE. Bristeau, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1969. 108p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, France.

Experiments were carried out on the total ionization by α particles in pure gases and gaseous mixtures containing metastable atoms, as a function of temperature. By different experimental method, the results for the mean ionization energy at 300°K given by Jesse in 1953 were confirmed to within 1 percent. It was established that in pure gases the mean energy W required to form a pair of ions remains constant as the temperature varies from 77 to 300°K. It is shown that there is a temperature effect for W in binary gas mixtures of the type A–B containing metastable atoms A* and an "impurity" B. A systematic study was made of the change ΔW in W as a function of the temperature and of the B concentration in the mixtures Ne–Ar, Ne–Kr, Ne–H_2, Ne–N_2, Ne–CH_4, and He–Ar. Experiments were carried out on a ternary gas mixture of the type A–B–C, where C is a second ionizable "impurity" added to the binary mixture A–B; they show the existence of excited atoms B*. Finally, it is shown that the number of metastable atoms formed in a pure gas must be very close to the number N_0 of ion pairs, and that there must exist a correlation between the number N_0 of ion pairs and the number N_0 of metastable atoms created in the pure rare gases. (auth)

32155 (ORNL-AMPIC-12) BIBLIOGRAPHY OF ATOMIC AND MOLECULAR PROCESSES FOR JULY–DECEMBER 1968. (Oak Ridge National Lab., Tenn.). June 1969. 243p. Dep. CFSTI.

Part I of this publication is an annotated bibliography containing references of interest to atomic and molecular collision research. The references are classified into twelve major categories with appropriate subcategories. Each entry in the respective category is entered alphabetically by first author and includes the reactants of the collision process. Part II is a listing of scientists engaged in or interested in the field of atomic and molecular collisional physics. Part III lists Russian scientists engaged in atomic collision physics; the listing is obtained from publications and scientific conferences. (auth)

32156 (ORO-3027-15) THE EXCITATION AND IONIZATION OF IONS BY ELECTRON IMPACT. Technical Progress Report, September 1, 1968–May 31, 1969. Hooper, J. W.; Majure, J. C.; McPherson, D.; Pace, M. O. (Georgia Inst. of Tech., Atlanta. School of Electrical Engineering). May 31, 1969. Contract AT(40-1)-3027. 32p. Dep. CFSTI.

Research conducted during the period in each of the following experimental areas is described briefly: (a) the development of facilities and techniques suitable for the determination of electron-collision data from magnetoplasma transient-response studies; (b) energy loss by protons and singly charged Li ions upon passage through thin films; and (c) the determination of absolute cross sections for excitation of Ba^+ ions by electron impact for electron energies near threshold for the processes of interest. The descriptions cover equipment and experimental methods; no results are given. (A.G.W.)

32157 (UUIP-589) HIGH RESOLUTION OBSERVATIONS OF AUTOIONIZATION ELECTRON SPECTRA. Bergmark, T.; Spohr, R.; Magnusson, N.; Werme, L. O.; Nordling, C.; Siegbahn, K. (Uppsala Univ. (Sweden). Inst. of Physics). Mar. 1969. 24p. Dep.

High-resolution observations were made of electron spectra from auto-ionization processes in the rare gases He, Ne, Ar, Kr, and Xe. The electron spectra, excited by impact of electrons with an energy of several keV, were measured in the energy range 5 to 45 eV by a spherical electrostatic spectrometer. New Rydberg series of electron lines were found, which correspond to transitions from excited states of neutral atoms to the ground state of the ions. Electron impact also induces radiationless transitions from singly to doubly ionized atoms. Except in Xe these so-called Auger spectra appear at higher energies and have been dealt with elsewhere. (auth) (Sweden)

32158 NOTE ON THE L- AND M-SHELL IONIZATION BY HEAVY CHARGED PARTICLES. Hansteen, J. M.; Mosebekk, O. P. (Univ. of Bergen). Phys. Lett., 29A: 281-2(May 19, 1969).

The process of L- and M-shell ionization of atoms by heavy, charged particles is analyzed by a semiclassical, time-dependent perturbation method. In the M-shell contributions from the 3s and 3p subshells only are considered. (auth)

32159 STRIPPING AND IONIZATION IN LOW-ENERGY COLLISIONS OF H ON O_2 AND N_2. Fleischmann, H. H. (Cor-

nell Univ., Ithaca, N. Y.); Young, R. A. Phys. Lett., 29A: 287-8(May 19, 1969).

Negative-charge production was measured for hydrogen-beam energies of 50 to 800 eV. Comparison with stripping measurements at higher energies indicates uniform trend of the ratio of target ionization to projectile stripping with the ionization potential of the target particles. (auth)

32160 ELECTRON-IMPACT SPECTRUM OF MERCURY VAPOR. Skerbele, Ausma; Ross, Kevin J.; Lassettre, Edwin N. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 50: 4486-93(May 15, 1969).

Electron-impact spectra of mercury vapor have been investigated at incident electron energies between 50 and 300 eV. An intensity anomaly (expected from previous studies of atomic spectra) has been observed in the $6^1S_0 \rightarrow m^1P_1$ series due to a perturbation by the $6p'^1P$ state. Relative cross sections and oscillator strengths have been calculated from the intensity data at 300 eV and zero scattering angle. (auth)

32161 DIFFERENTIAL ELASTIC SCATTERING OF LOW-ENERGY PROTONS BY ARGON ATOMS. Herrero, F. A.; Nemeth, E. M.; Bailey, T. L. (Univ. of Florida, Gainesville). J. Chem. Phys., 4591-2(May 15, 1969).

Relative differential cross sections for the elastic scattering of H^+ ions by Ar atoms were measured at six laboratory collision energies from 12.7 to 44.1 eV. Plots of relative differential cross section versus cms scattering angle exhibit pronounced oscillatory structure. The results are interpreted in terms of a scaled three-parameter 12-6-4 potential using the semiclassical theory of rainbow scattering. Lack of agreement between experiment and calculations suggests the desirability of absolute differential cross-section measurements, from which better estimates of internuclear separation at the potential minimum can be made, and of calculations of the classical deflection function and its derivatives for scaled potentials more flexible than the 12-6-4. (A.G.W.)

32162 CALCULATION OF ATOM-ATOM EXCITATION CROSS SECTIONS BY CLASSICAL METHODS. Russell, G. R. (Jet Propulsion Lab., Pasadena, Calif.). J. Chem. Phys., 50: 4597-8(May 15, 1969).

Derivation of an analytical expression for excitation cross sections for atom-atom collisions from Thomson's classical theory is demonstrated. The expression was used to calculate values for helium, argon, krypton, and xenon, and the results are compared with experimental and other theoretical results. Agreement is considered to be excellent. (A.G.W.)

32163 EVIDENCE FOR THE FORMATION OF NEUTRAL RARE-GAS MOLECULES BY ELECTRON-BEAM PULSES. Arai, Shigeyoshi; Firestone, Richard F. (Ohio State Univ., Columbus). J. Chem. Phys., 50: 4575-89(May 15, 1969).

Intense emission and absorption signals in the visible and near-infrared regions have been induced by submitting Ne, Ar, Kr, and Xe and binary mixtures of these gases to brief intense pulses of 500-keV electrons. Measurements of the intensities of these signals as functions of time have been made with a time resolution of ~40 nsec. The majority of the observed signals are attributed to 1s-2p atomic transitions. The lifetimes of the 2p atoms are shown to have been of the order 10^{-7} to 10^{-6} sec and to decrease with increasing pressure at 200 to 1500 torr. Absorption signals appearing in the near-infrared region unaccompanied by characteristic atomic emission signals were strongly inhibited by presence of a heavier rare gas and exhibited longer rise times than the atomic signals. These near-infrared absorption signals are tentatively attributed to neutral, probably diatomic, rare-gas molecules. (auth)

32164 ABSOLUTE DETERMINATION OF THE TOTAL EXCITATION CROSS SECTIONS OF RARE GASES DURING ELECTRON COLLISIONS. Schaper, M.; Scheibner, H. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 9: 45-57 (1969). (In German).

With an improved Maier-Leibnitz collision chamber, absolute values of the total excitation cross sections of the rare gases were measured. The half-width of energy distribution in the beam of exciting electrons was approximately 0.7 eV. The results for He and Ne are in reasonable agreement with the excitation functions given by Maier-Leibnitz, if some necessary corrections (especially with regard to contact potentials) are made. The cross sections obtained in this study are slightly smaller. Better fine structure yielded more favorable possibilities of comparison with other measurements published so far. The error should not be greater than 30%. (auth)

32165 THRESHOLD BEHAVIOR OF THE CROSS SECTION FOR THE EXCITATION OF Cs II RESONANCE LINES IN THE PROCESS $Cs^+ + He$. Babashev, S. V.; Matveev, V. B.; Ankudinov, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 9: 201-4(Mar. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 344-7(Mar. 20, 1969).

The experimental thresholds of three resonant lines of Cs II produced as a result of the reaction $Cs^+ + He \rightarrow Cs^{+*} + He$ were studied. The results indicate that the behavior of the cross section for excitation of the lines is influenced by the approach of the turning points and of the pseudointersection point of the potential terms of the quasi molecule Cs^+He. (A.G.W.)

32166 FORMATION OF EXCITED CARBON IONS IN $He^+ + CO$ COLLISIONS. Lipeles, M. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Lett., 29A: 297-8(June 2, 1969).

The dissociation of CO to the $4f^2F^0$ state of C^+ was observed by its emission in low-energy (100 eV to 1 keV) collisions with He^+. (auth)

32167 ANGULAR DISTRIBUTION OF ELECTRONS ELASTICALLY SCATTERED BY HELIUM ATOMS. Khare, S. P. (Indian Inst. of Tech., Bombay). Phys. Lett., 29A: 355-6(June 2, 1969).

The differential cross sections for the elastic scattering of electrons by helium atoms are obtained in the static field and dipole polarization plus exchange approximation and also in the plane wave approximation. The results are in good agreement with each other and also with the experimental data. (auth)

32168 DISSOCIATION OF FAST H_2^+ AND D_2^+ IONS INDUCED BY COLLISION WITH ATOMS AND MOLECULES. Durup, Jean; Fournier, Paul; Dong, Pham (Faculte des Sciences, Orsay, France). J. Mass Spectrom. Ion Phys., 2: 311-32(May 1969).

The dissociation of H_2^+ and D_2^+ ions, induced by collision with various target atoms or molecules, was studied in the range 3 to 5 keV. The kinetic energy distribution of fragment ions was measured for varying energies of the electrons used for producing the incident ions, in the vicinity of the ionization threshold. From these measurements the distribution of the excess energy of the fragments in the system of the center-of-mass of the incident ion was derived. The energy loss experienced by the incident ions as a result of the collision, and prior to their dissociation, was also measured. The conclusions are in agreement with those recently given by Vogler and Seibt in a study of the same collisions at higher ion energies and higher ionizing electron energies. The main process is a "vertical" $1s\sigma_g - 2p\sigma_u$ excitation of the incident ions. A competing process is the excitation of the ion to the vibrational continuum of its ground state accompanied by electronic excitation of the target. A model for the latter process is proposed. (auth)

32169 THRESHOLD IONIZATION EFFICIENCY CURVES FOR MONOENERGETIC ELECTRON IMPACT ON H_2, D_2, CH_4, AND CD_4. Lossing, F. P.; Semeluk, G. P. (National Research Council of Canada, Ottawa). J. Mass Spectrom. Ion Phys., 2: 408-13(May 1969).

A combined electron energy selector and quadrupole mass analyzer was used to investigate the ionization efficiency for electron impact on hydrogen, deuterium, CH_4, and CD_4. The electron beam distribution had an energy width at half-height of about 0.06 V. The resulting ionization efficiency curves display some similarities to and some differences from published results. (auth)

32170 MULTIPLE EXCITATION OF A MANY-ELECTRON SYSTEM BY PHOTON AND ELECTRON IMPACT IN THE SUDDEN APPROXIMATION. Aberg, Teijo (Univ. of Helsinki, Otaniemi, Finland. Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser A IV, No. 308, 46p.(Feb. 1969).

Atomic correlation is introduced in the sudden-approximation treatment of excitation accompanying ionization of a many-electron system. The relationship between the first Born approximation and the sudden approximation is shown. In the case of photon impact both approximations yield, in the high-energy limit, identical relative multiple-excitation cross sections for an arbitrary initial-state wave function, provided that the velocity form but not the length form of the Born cross section is used. In the case of electron impact, this equality is valid in general only if the correlation in the initial state between the knocked-out electron and the other electrons is weak. The sudden-approximation calculations made are found to be in agreement with photon-impact experiments for both strong (KK excitation of the helium atom) and weak (KL and KL^2 excitation of various atoms and ions) correlation. Agreement with electron-impact experiments is found for weak (KL excitation)

correlation, but there is disagreement in the case of KK ionization of the helium atom bombarded by charged particles. (auth)

32171 FLUORESCENCE YIELDS OF L SUBSHELLS IN HEAVY ELEMENTS. Price, Richard Ernest. Berkeley, Calif., Univ. of California, 1968. 92p.

Thesis.

Experimental measurements of L_2 and L_3 subshell fluorescence yields for elements 71 through 83, 90, and 92 are reported. The method consisted of photo-exciting K-shell vacancies in thin metal or oxide samples, observing with a Ge(Li) spectrometer the $K\alpha_1$ or $K\alpha_2$ x rays emitted as the K vacancies moved to the L_3 or L_2 subshell, and counting absolutely the L x rays that signify radiative filling of those vacancies. In interpreting the measurement, the value zero was assumed for the Coster–Kronig transition yield f_{23}. The ω_2 results may be revised if, in the future, better values of f_{23} become available. Estimated precision (two standard deviations) varies between 8 and 15%. ω_3 results lie among the highest of previous determinations. ω_2 data lie between previous conflicting results. (Disser. Abstr.)

32172 TEMPERATURE DEPENDENCE OF SLOW ION–ATOM INTERCHANGE REACTIONS. Ferguson, E. E.; Bohme, D. K.; Fehsenfeld, F. C.; Dunkin, D. B. (Environmental Science Services Administration, Boulder, Colo.). J. Chem. Phys., 50: 5039-40(June 1, 1969).

A qualitative reaction model is proposed to explain the decreasing rate constant with increasing temperature previously found experimentally for the reactions $O^+ + N_2 \rightarrow NO^+ + N$ and $O^+ + NO_2 \rightarrow O_2^+ + O$. The proposed mechanism is $O^+(^4S) + N_2(^1\Sigma) \rightarrow N_2O^{+*}$ followed by $N_2O^{+*} \rightarrow NO^+(^1\Sigma) + N(^4S) + 1.1\ eV \rightarrow O^+(^4S) + N_2(^1\Sigma) + 0\ eV$. The essence of the model is the assertion that the N_2O^{+*} (or any other) complex will be more likely to decay into the most exothermic channel the longer the complex lifetime. (A.G.W.)

32173 COMPTON SCATTERING FACTORS FOR ASPHERICAL FREE ATOMS. Cromer, Don T. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 50: 4857-9(June 1, 1969).

Incoherent scattering factors for all aspherical free atoms have been computed from numerical SCF Hartree–Fock wavefunctions. The complete Waller–Hartree theory with all exchange terms has been used. (auth)

32174 PRIMARY SPECIFIC IONIZATION OF RELATIVISTIC PARTICLES IN GASES. Ermilova, V. K.; Kotenko, L. P.; Merzon, G. I.; Chechin, V. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1608-18(May 1969). (In Russian).

Formulas are proposed and calculations are performed for the primary specific ionization in noble gases and in H_2, N_2, and O_2 by taking into account polarization of the medium. It is shown that at relativistic energies the dependence of the primary specific ionization on the particle Lorentz factor γ is similar to that for specific energy losses; however, the primary ionization plateau begins at smaller values of γ. The minimum absolute values of the primary specific ionization in He, Ne, Ar, Xe, H_2, N_2, and O_2 at normal temperatures and pressures are calculated to be respectively 3.5, 11.4, 25.8, 49.6, 5.1, 27.1, 28.9 ion pairs per cm; the plateau exceeds the minimum correspondingly by 48.7, 58.7, 41.6, 40.6, 36.1, 43.8, and 52.2%. Some simplified expressions for calculation of the primary specific ionization at various gas pressures are given. The mean ionization potentials of the gases are calculated. The results are compared with the available experimental data. (auth)

32175 POSSIBILITY OF EXTRACTING ANISOTROPY PARAMETERS FROM THE M DEPENDENCE OF TOTAL CROSS-SECTION MEASUREMENTS. Miller, William H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 50: 3410-15(Apr. 15, 1969).

The total cross section for the collision of an atom and a diatomic molecule (rigid rotor) initially in rotational state (J_a, M_a) is computed to first order in the anisotropic part of the potential. The dependence of the cross section on the quantum number M_a is examined, and it is seen that the anisotropy of the long-range attractive part of the potential can be determined from the M_a dependence of the average (average over glory oscillations) cross section, whereas the anisotropy of the short-range repulsive part of the potential can be determined from the M_a dependence of the glory oscillations. (auth)

32176 POSSIBILITY OF EXTRACTING ANISOTROPY PARAMETERS FROM TOTAL CROSS-SECTION MEASUREMENTS. II. Miller, William H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 50: 3868-72(May 1, 1969).

The total (integrated) cross section for the collision of an atom and a diatomic molecule (rigid rotor) is computed in the distorted-wave Born approximation (DWBA) in order to see how information concerning the anisotropic potential can be obtained from such measurements. It is seen that the anisotropy parameters can be obtained most directly from the amplitude of the oscillatory contribution to the cross section. The frequency of the oscillations is determined by the velocity dependence of the rainbow angle of the spherically symmetric distorting potential and (to lowest order) contains no dependence on the anisotropy. Elastic and inelastic transitions are treated. (auth)

32177 CALCULATION OF BREMSSTRAHLUNG CROSS SECTIONS WITH SOMMERFELD–MAUE EIGENFUNCTIONS. Elwert, Gerhard; Haug, Eberhard (Univ., Tuebingen, Ger.). Phys. Rev., 183: 90-105(July 5, 1969).

A formula for the differential cross section of bremsstrahlung is calculated with the aid of Sommerfeld–Maue eigenfunctions, i.e., under the assumption of a pure Coulomb field and low atomic numbers ($\alpha Z \ll 1$). This expression is valid for all energies of both electrons and photons, and it is shown that the previously well-known formulas of Sommerfeld, Sauter, Bethe, Heitler, Scherzer, and Bethe and Maximon are contained as special cases. Hence this cross section is correct for high electron energies and, apart from a small spin correction, for nonrelativistic energies even if $\alpha Z \ll 1$ is not satisfied. The formula has been programmed, and in addition total cross sections have been obtained by numerical integration over the angles of the emitted electrons and photons. Comparison with the Born approximation allows derivation of the Coulomb correction. Several cases of interest are compared with experiment, in particular the elementary bremsstrahlung process itself, for which experimental results are now available. (auth)

32178 ASYMPTOTIC SPECTRUM OF BREMSSTRAHLUNG RADIATION. Oppenheim, Alan (Polytechnic Inst. of Brooklyn). Phys. Rev., 183: 123-8(July 5, 1969).

A new, tractable asymptotic expression is found for the energy spectrum of bremsstrahlung radiation emitted during an attractive Coulomb interaction between two particles at nonrelativistic energies. The expression is valid over the full range of energetically allowed orbit parameters, and explicitly exhibits an exponential dependence on frequency, on the eccentricity of the hyperbolic orbit, and on an appropriate function of the energy. (auth)

32179 DISSOCIATIVE ATTACHMENT OF ELECTRONS TO HOT OXYGEN. Henderson, W. R.; Fite, W. L.; Brackmann, R. T. (Univ. of Pittsburgh). Phys. Rev., 183: 157-66(July 5, 1969).

Crossed-beam experiments on dissociative attachment to form O^- ions in collisions of electrons with oxygen molecules are described. In these experiments the temperature of the oxygen beam source was varied and very strong changes in the cross section as a function of temperature were displayed indicating marked enhancement of the cross section with increasing internal energy in the O_2 prior to the collision with the electron. A separate thermal equilibrium experiment verified the accepted affinity of ground-state O^-, and experiments using free jet expansion of the heated O_2 indicated that the form of internal energy responsible for the enhancement of the cross section is vibrational excitation, in accord with the theory given by T. F. O'Malley. Absolute determinations of the cross sections at different temperatures were made and found to be in accord with O'Malley's predictions. (auth)

32180 SEMICLASSICAL THEORY OF ELASTIC PERTURBATIONS. Marchi, R. P. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., 183: 185-92(July 5, 1969).

The Stueckelberg formulation for transition probabilities is utilized to explain perturbation effects observed in elastic differential cross-section measurements. The model based on a competing trajectory concept implies oscillating cross sections for all inelastic processes occurring by means of a curve-crossing mechanism. Variations are made in the slopes of two crossing potential-energy curves to determine the effect on the cross section. The model gives qualitative agreement with experiment, but definitive tests must await more accurate potential-energy curves. (auth)

32181 AN IMPROVEMENT IN THE FIRST BORN THEORY OF ELECTRON SCATTERING BY MOLECULAR SYSTEMS. I. THEORY. Peek, James M. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., 183: 193-202(July 5, 1969).

The asymptotic or Bethe expansion of the first Born cross section, for large magnitude of the initial collision velocity V, is considered for a particular electronic excitation of a molecular target. The sum of the Bethe cross section over the complete set of wave functions for nuclear motion in the final electronic state is shown to be asymptotic to the analogous sum of the Born cross section over states allowed by energy conservation. The closure relation is then used to simplify the matrix elements that

define the Bethe cross section without further approximation. The advantages gained by this approach are demonstrated in the following paper by the treatment of a particular example. (auth)

32182 IMPROVEMENT IN THE FIRST BORN THEORY OF ELECTRON SCATTERING BY MOLECULAR SYSTEMS. II. EXAMPLE OF THE $1s\sigma_g - 2p\sigma_u$ TRANSITION IN H_2^+. Peek, James M.; Green, Thomas A. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., 183: 202-12(July 5, 1969).

The asymptotic closure cross section, derived in I of this series, is calculated for the $1s\sigma_g - 2p\sigma_u$ excitation of H_2^+ by fast electrons. These data are compared with earlier treatments of this system based on a less rigorous theory. The earlier data are observed to be surprisingly accurate. The Bethe cross section for exciting discrete vibrational modes in the $2p\sigma_u$ orbital of H_2^+ is calculated. This cross section is then used, along with the asymptotic closure cross section, to generate the Bethe cross section for all continuum modes of nuclear motion in the $2p\sigma_u$ orbital of H_2^+. Two approximations are considered for this partitioning of the asymptotic closure cross section and they are not found to be, in general, very useful. (auth)

32183 PRODUCTION AND LOSS OF FAST METASTABLE HELIUM ATOMS IN COLLISIONS WITH Xe, H_2, Ar, AND He. Miers, R. E.; Schlachter, A. S.; Anderson, L. W. (Univ. of Wisconsin, Madison). Phys. Rev., 183: 213-16(July 5, 1969).

Cross sections for production and destruction of fast ^{0}He atoms in triplet states have been measured for 10- to 30-keV He^+ ions incident on gas targets of Xe, H_2, Ar, and He. In a Cs vapor the production of positive and negative ions of He is sensitive to the fraction of metastable triplet atoms in the incident ^{0}He beam so that it is possible to use a thin Cs vapor target to analyze the fraction of triplet metastable atoms among the fast ^{0}He atoms emerging from the gas target of Xe, H_2, Ar, or He. The fraction of neutral ^{0}He atoms in the triplet metastable state emerging from thin targets of Xe, H_2, Ar, and He are 0.19 ± 0.07, 0.08 ± 0.04, 0.05 ± 0.02, and <0.02, respectively, for incident He^+ energies of 25 keV. (auth)

32184 CHARGE-EQUILIBRIUM FRACTIONS OF A HELIUM BEAM IN HYDROGEN, NITROGEN, NEON, AND ARGON FROM 60 TO 850 keV. Torres, P.; Meckbach, W.; Valenzuela, A. (Centro Atomico Bariloche, San Carlos de Bariloche, Argentina. Instituto de Fisica Dr. J. A. Balseiro, San Carlos de Bariloche, Argentina). Phys. Rev., 183: 216-20(July 5, 1969).

Equilibrium fractions of charge 0, +1, and +2 of helium beams traversing the gas targets H_2, N_2, Ne, and Ar have been measured. Primary beams of $(^4He)^+$ and $(^3He)^{2+}$ were used. The measurements cover ion velocities corresponding to energies of $(^4He)^+$ between 60 and 850 keV. The charge-equilibrated beam was magnetically separated and charge spectra were recorded by means of a movable detector of equal sensitivity for all three charge components. In the energy interval of overlap, that is between 60 and 200 keV, agreement with Barnett et al. is excellent in the fractions $F_{0\infty}$ and $F_{1\infty}$, which make up almost the entire charge-equilibrated beam. The results show a strong dependence of the equilibrium charge distributions on the chemical nature or electronic configuration of the gas target. (auth)

32185 POLARIZATION AND EXCHANGE EFFECTS IN LOW-ENERGY ELECTRON–H_2 SCATTERING. Henry, Ronald J. W. (Kitt Peak National Observatory, Tucson, Ariz.); Lane, Neal F. Phys. Rev., 183: 221-31(July 5, 1969).

The scattering formalism of Arthurs and Dalgarno, as generalized by Ardill and Davison, is used to take account of exchange in the scattering of slow electrons by molecular hydrogen. Adiabatic polarization terms are included in the direct potential. Exchange and polarization effects on elastic and $0 \rightarrow 2$ and $1 \rightarrow 3$ rotational excitation of H_2 by electron impact are found to be important for energies less than 10 eV. In the energy ranges where measurements and theory overlap, good agreement is obtained for total and differential cross sections, as well as for $0 \rightarrow 2$ and $1 \rightarrow 3$ rotational excitation cross sections. (auth)

32186 IMPACT-PARAMETER TREATMENT OF HYDROGEN–HYDROGEN EXCITATION COLLISIONS. I. TWO-STATE APPROXIMATION. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev., 183: 231-40 (July 5, 1969).

The impact-parameter versions of the full two-state and the Born approximations are used to calculate the n = 2 and 3 single-excitation cross sections describing collisions between two ground-state hydrogen atoms. Effects similar to those encountered by Bates in his distortion calculations of the 2s and 2p excitations of hydrogen by proton impact are observed. Cross sections for excitation up to the 4s state are also provided by using the Born approximation. The percentage polarization of impact radiation emitted is evaluated. (auth)

32187 IMPACT-PARAMETER TREATMENT OF HYDROGEN–HYDROGEN EXCITATION COLLISIONS. II. FOUR-STATE APPROXIMATION. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev., 183: 241-4 (July 5, 1969).

An impact-parameter treatment is carried out for the processes H(1s) + H(1s) → H(1s) + H(2s or 2p) with incident hydrogen-atom energies E in the range $360 \text{ eV} \leq E \leq 100$ keV. Full account is taken of distortion, back coupling, rotational coupling, and the virtual transition sequence $1s \rightleftharpoons 2p \rightleftharpoons 2s$. Comparison with previous two-state calculations, which included only the effects of distortion and back coupling, shows that the presence of the optically allowed $1s-2p$ transition increases the $1s-2s$ cross section at all energies, augmenting it by as much as 73% at 360 eV, and contributes relatively less with increasing energy. For excitation of the 2p-magnetic components, rotational coupling and the inclusion of the optically forbidden channel influence the cross sections only slightly and in opposite senses for energies above 6 keV, while for lower energies their combined effect is to decrease severely the excitation probabilities. The percentage polarization of the emitted radiation is also evaluated. (auth)

32188 LOW-ENERGY SCATTERING OF ELECTRONS BY HELIUM. Burke, P. G. (Queens Univ., Belfast); Cooper, J. W.; Ormonde, S. Phys. Rev., 183: 245-64(July 5, 1969).

The close-coupling equations for electron–helium scattering have been solved in the energy range near the n = 2 thresholds. Cross sections for elastic scattering from both ground and excited states, for excitation of the ground state to the n = 2 states (2^3S, 2^1S, 2^3P, and 2^1P), and for excitation and de-excitation processes involving only the n = 2 levels are presented and compared with experimental evidence on total metastable production, on angular distributions of excitation cross sections to the n = 2 levels, and on processes involving only the n = 2 states. The percentage polarization of light emitted by electron-impact excitation to the 2^3P and 2^1P states is computed and compared with experiment. The calculations indicate the importance of resonances in near-threshold excitation and de-excitation processes in He. An attempt has been made to understand the resonant structure by considering both the energy dependence of the eigenphases of the many-channel S matrix produced by solving the close-coupling equations and the energy dependence of eigenvalues of the related time-delay matrix. (auth)

Atomic Theory

32189 HULTHEN APPROXIMATIONS TO 1s AND 2p ORBITALS OF ATOMS. Weare, John H.; Weber, Thomas A.; Parr, Robert G. (John Hopkins Univ., Baltimore). J. Chem. Phys., 50: 4393-4401(May 15, 1969).

It is shown that a substantial energy improvement over the Slater-orbital description is obtained by the variational use of 0s and 1p functions in the 1s and 2p shells of atoms, where 0s and 1p represent differences of two Slater 0s and Slater 1p functions, respectively. Reduction of the number of parameters by enforcing nuclear cusp conditions does not affect the variational energy significantly. The reduction yields one-parameter 0s and 1p orbitals giving a better energy than both one-parameter Slater functions and two-parameter variable-principal-quantum-number functions. It is also shown that in correlated functions of the form $\psi = \phi(r_1)\phi(r_2)\chi(r_{12})$, the orbital 0s when used as a one-term approximation to the best possible ϕ gives an excellent result for the energy of helium-like systems and the correlation function $1 + c \exp(-\eta r_{12})$ gives a very good approximation to the best $\chi(r_{12})$. Reduction of the number of parameters by requiring both nuclear and correlation cusp conditions yields a two-parameter trial function, which for helium has the energy −2.90002 a.u., vs the Roothaan–Weiss best energy, −2.90039 a.u., for a function of this form. (auth)

32190 NONEXISTENCE OF 1sns AUTOIONIZING STATES OF H^-. Wallis, Anthony; McElwain, D. L. S.; Pritchard, H. O. (York Univ., Toronto). J. Chem. Phys., 50: 4543-5(May 15, 1969).

The convergence and coalescence properties of a two-electron wave function containing integral powers and exponential terms in r_1, r_2, and r_{12} have been investigated. Solutions were obtained for the singlet and triplet 1sns states for both integral and non-integral values of the nuclear charge Z, and it is concluded that the 1sns manifold converges to a degenerate eigenvalue as $Z \rightarrow 1$ for all $n \geq 2$. (auth)

32191 DOES ATOMIC RADIATION EXIST FOR WHICH THE BOHR LAW DOES NOT HOLD? Lochak, Georges; Thiounn, Mumm

(Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 268: 897-900(Mar. 31, 1969). (In French).

It is shown that in wave mechanics the law of Bohr frequencies and the Schroedinger emission law lead to incongruous estimates for certain resonance phenomena. Two types of experiments are indicated that should test the applicability of the two laws. (tr-auth)

32192 OBSERVATIONS CONCERNING THE USE OF PERTURBATION THEORY FOR THE IMPROVEMENT OF APPROXIMATE WAVE FUNCTIONS. Vladimiroff, T. (State Univ. of New York, Stony Brook). J. Chem. Phys., 50: 5044-5(June 1, 1969).

When a solution for the Hamiltonian H is desired and only an approximate wave function Ψ_A is available, and operator H_A such that $H_A\Psi_A = E_A\Psi_A$ can be formally constructed. A perturbation operator $(H - H_A) \equiv \lambda W$, once defined, can be used to calculate corrections to Ψ_A to any desired order in λ. A method for minimizing the effect of the operator λW is described. It is pointed out that the resulting variational principle is just a special case of a variational principle already proposed by Preuss [Fortschr. Physik, 10: 271 (1962)]. (A.G.W.)

32193 SPIN DEGENERACY AND THE STABILITY OF HARTREE–FOCK STATES. Lunell, Sten (Univ. of Florida, Gainesville); Lindner, Peter. J. Chem. Phys., 50: 4679-85 (June 1, 1969).

The stability of a Hartree–Fock determinant under a splitting of the doubly occupied orbitals with simultaneous symmetry projection is studied. As a consequence of the spin degeneracy, the energy is given by the lowest root to a secular equation. It is found that even for an infinitesimal splitting of the orbitals there will be a discontinuous, finite lowering of the energy for both closed-shell and open-shell states. Numerical illustrations are given by the Li and Be atoms, the H_4 molecule, and the benzene molecule. (auth)

32194 SPIN-OPTIMIZED SELF-CONSISTENT-FIELD WAVE FUNCTIONS. Kaldor, Uzi (Stanford Univ., Calif.); Harris, Frank E. Phys. Rev., 183: 1-7(July 5, 1969).

A method is given for determining a spin-optimized self-consistent-field (SO–SCF) function based on optimized spatial orbitals and a spin function that is optimum in the S, M_s spin space. Results are presented for $Li(^2S)$, $Li(^2P)$, $Be^+(^2S)$, $B^{2+}(^2S)$, and $Be(^1S)$. SO–SCF wave functions and energies are very similar to those obtained with restriction to the normally paired spin function, but the use of the entire spin space greatly improves the description of spin-dependent properties. Whereas single-spin-function calculations of the spin density at the nucleus are for $Li(^2S)$ and $Li(^2P)$, respectively, 9 and 100% in error, the corresponding SO–SCF errors are only 2% and 7%. (auth)

32195 ORBITAL SELF-CONSISTENT-FIELD THEORY. II. NATURAL ORBITAL HAMILTONIAN. Adams, William H. (Rutgers-The State Univ., New Brunswick, N. J. Argonne National Lab., Ill.). Phys. Rev., 183: 31-6(July 5, 1969).

A constrained energy extremal principle for natural orbitals and natural spin orbitals is demonstrated. The extremal principle is used to derive a one-electron Hamiltonian for natural spin orbitals of a system of N electrons. The natural spin-orbital Hamiltonian depends on the one- and two-body density matrices, and is thus of the self-consistent-field type. Whether or not the natural spin-orbital Hamiltonian will be of any practical significance in the determination of exact or accurate natural spin orbitals depends upon finding a practical solution of the N-representability problem. (auth)

32196 ORBITAL SELF-CONSISTENT-FIELD THEORY. III. HAMILTONIAN FOR THE NATURAL ORBITALS OF MULTICONFIGURATIONAL WAVE FUNCTIONS. Adams, William H. (Rutgers-The State Univ., New Brunswick, N. J. Argonne National Lab., Ill.). Phys. Rev., 183: 37-45(July 5, 1969).

A self-consistent-field Hamiltonian that determines the natural orbitals of a multiconfigurational wave function is derived. The advantage of using natural orbitals in multiconfigurational wave functions is that one can then determine the Lagrangian multipliers once and for all. The Hamiltonian is valid for almost all of the proposed multiconfigurational wave functions, including those for which self-consistent-field equations have not been previously given. The Hamiltonian is derived by combining the results of Parts I and II of this series. It is derived in such a way that it contains explicitly electronic Coulomb and exchange operators. This has the advantage that the coupling operators that appear in the Hamiltonian depend only on that part of the two-electron density matrix that describes the correlation between the electrons. The practical question of how to use the derived equation is discussed in a brief general way. (auth)

Cosmic Radiation

Refer also to abstracts 31553, 31594, 31750, 32095, 32104, 32633, 32673, and 32894.

32197 (AECL–3283) COSMIC RAY NM-64 NEUTRON MONITOR DATA. [PART] XI. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1969. 90p. Dep. CFSTI. CAN $2.00.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada using equipment maintained by AECL are given in tabular form for the period from Sept. to Dec., 1968. Normalized graphs are given for the same period. (auth)

32198 (CEA-R–3674(E)) THEORETICAL GALACTIC COSMIC RAY ELECTRON SPECTRUM OBTAINED FOR SOURCES OF VARYING GEOMETRY. Cohen, Moses Elias (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 50p. Dep.

Jokipii and Meyer, Phys. Rev. Lett., 20: 752(1968)) obtained an electron density energy spectrum of galactic cosmic rays using integral solutions of the steady-state transfer equations, by considering a circular cylindric galactic disc as source and approximating the resulting fourth-order integral. In this report, general results obtained by using an arbitrary circular cylindrical source are presented, without restriction to the galactic disc. The integrals are treated exactly. The conclusions of Jokipii and Meyer form special cases of these results. An exponential energy variation was obtained which, at the moment, is not observed experimentally. The second part of this work deals with more complicated, but perhaps more realistic models of elliptic cylindrical and ellipsoidal galactic disc sources. One may also note that a very large source concentrated in a very small region gives a spectrum not unlike that for a small source distributed throughout a large volume. Finally, it may be remarked that the model adopted is much less restrictive than the artificial conception of "leakage time" followed by other workers. (auth)

32199 COSMIC RAYS AT SUPERSONIC-TRANSPORT ALTITUDES. Fukui, Katsura. Res. Rev. (Office Aerosp. Res.), 7: No. 10, 11(Oct. 1968).

A very brief report is given on results of three balloon flights to 130,000, 70,000, and 60,000 feet to obtain quantitative data on the energies and fluxes of heavy cosmic-ray nuclei. It is concluded that the atmospheric shielding coupled with the additional shielding of the aircraft-fuselage metal, serves to protect the passengers and crew almost completely from the ionizing radiation of heavy primaries. (W.D.M.)

32200 COSMIC-RAY MEASUREMENTS IN THE STRATOSPHERE OVER THE ARCTIC AND ANTARCTICA. Vernov, S. N.; Charakhch'yan, A. N.; Stozhkov, Yu. I.; Charakch'yan, T. N. (Levedev Inst. of Physics, Moscow. Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 891-2(1968).

Translated from Geomagn. Aeron., 8: 1102-3(1968).

An RK-1 radiosonde has been used since 1963 for simultaneous daily measurements of cosmic-ray intensity in the stratosphere over Murmansk ($\Phi = 64°N$, $E_{cr} = 100$ MeV) and over Mirny ($\Phi = 78°S$, $E_{cr} \sim 10$ MeV). The results of measurements at these two points were analyzed in a study of the temperature dependence of cosmic-ray intensity in the stratosphere and also for investigation of the degree of anisotropy of primary cosmic radiation in interplanetary space. (W.D.M.)

32201 ANGULAR DISTRIBUTION OF LARGE SHOWERS ABNORMALLY POOR IN MUONS. Catz, Philippe; Gawin, Jerzy; Maze, Roland; Przasnyski, Marek; Wdowczyk, Jerzy; Zawadzki, Alexandre (Laboratoire de Physique Cosmique, Verrieres-le-Buisson, France. Univ., Lodz, Poland). Compt. Rend., Ser. B, 268: 945-8(Mar. 31, 1969). (In French).

The angular distribution of large showers abnormally poor in muons is flatter than normal. This result allows one to positively dispel the hypothesis that they can be due to extra-atmospheric photons. They are probably showers regenerated in the lower atmosphere by a relatively passive particle. The possible action of an intermediate boson is mentioned. (tr-auth)

32202 SOURCE REQUIREMENTS FOR THE FLUCTUATION ORIGIN OF COSMIC RADIATION. Wayland, J. R. (Univ. of Maryland, College Park). Phys. Rev., 180: 1232-9(Apr. 25, 1969).

An investigation is made of conditions placed upon a source of cosmic-ray particles within a model of the origin of cosmic rays in which fluctuations in the momentum-changing process are important. This is done by considering the relationship between (ΔP) and (ΔP^2), where ΔP is the momentum change in a collision. With the assumption that the energies due to turbulent motion, cosmic

rays, and the magnetic field are linearly related, an expression is found for the number density of cosmic-ray particles ejected from a changing volume in terms of their average kinetic energy. This is considered in terms of the fluctuation model to obtain other source requirements. It is found that over a large range of astrophysical phenomena the dominance of fluctuation can be important to the origin of cosmic radiation. (auth)

32203 DIRECTIONAL INTENSITY ANOMALIES OF THE PRIMARY COSMIC RAYS IN THE EAST–WEST PLANE. Park, Haeng Duk; Kwon, Nyong D. (Seoul National Univ.). New Phys. (S. Korea), 8: 83-7(Dec. 1968). (In Korean).

An attempt was made to confirm the existence of the fine-structure patterns. Results definitely reveal the existence of positionally symmetric prominences at Z = ±20° and further indicate other symmetric prominences in the neighborhood of Z = ±10°, ±40°. In addition to the main findings, it was determined that the magnitude of the east–west effect, the vertical absolute intensity, and the power ρ of $\cos^{\rho} Z$ intensity distribution are 0.41 ± 0.016%, 0.452 ± 0.0037, and 1.41 ± 0.021, respectively. (auth)

32204 LONG-TERM TIME VARIATIONS OF THE COSMIC-RAY ELECTRON FLUX ABOVE 500 MeV. Bleeker, J. A. M. (Kamerlingh Onnes Laboratorium, Leiden); Burger, J. J.; Deerenberg, A. J. M.; Scheepmaker, A.; Swanenburg, B. N.; Tanaka, Y. Phys. Rev. Lett., 22: 1325-6(June 16, 1969).

Balloon observations of the cosmic-ray electron spectrum in 1966, 1967, and 1968 show a reduction of the electron flux between 500 MeV and 5 GeV with increasing solar activity. (auth)

Direct Energy Conversion

32205 (AD–482170) THE MHD INDUCTION MACHINE. Pierson, Edward S.; Jackson, William D. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). May 1966. Contract AF33(615)-1083. 157p. (AFAPL–TR–65–107). CFSTI.

The Magnetohydrodynamic (MHD) Induction Machine is analyzed to determine the terminal properties, the power flow relations, and the steady-state performance characteristics. The theory for a machine of infinite length and width is first developed, including velocity-profile effects. Solutions are obtained for laminar (Hartman) flow in a narrow channel, and numerical results are presented for the arbitrary-channel case. Turbulent flow is treated by using a boundary-layer theory. The influence of finite length on generator performance is also considered. In each case, results are presented in terms of the electrical efficiency and power density. The performance and design implications of the results are discussed for several examples of MHD induction generators operated on liquid-metal flows. (auth) (USGRDR)

32206 (AE–355) THERMODYNAMIC ANALYSIS OF A SUPERCRITICAL MERCURY POWER CYCLE. Roberts, A. S. Jr. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1969. 25p. Dep.

A heat engine employing supercritical mercury as the working fluid and a magnetohydrodynamic (MHD) generator for thermal-to-electrical energy conversion is considered. The main emphasis is on power-cycle thermodynamics, where constraints are imposed by utilizing a MHD generator operating between supercritical, electrically conducting states of the working fluid; and, pump work is accomplished with liquid mercury. The temperature range is approximately 300 to 2200°K and system pressure is >1500 atm. Equilibrium and transport properties are carefully considered since these are known to vary radically in the vicinity of the critical point, which is found near the supercritical states of interest. A maximum gross plant efficiency is 20% with a regenerator effectiveness of 90% and greater, a cycle pressure ratio of two, and with highly efficient pump and generator. Certain specified cycle irreversibilities and others such as heat losses and heat exchanger pressure drops, which are not accounted for explicitly, reduce the gross plant efficiency to a few percent. Experimental efforts aimed at practical application of the power cycle are discouraged by the marginal thermodynamic performance predicted by this study, unless such applications are insensitive to gross cycle efficiency. (Sweden)

32207 (CEA–R–3714) STUDY OF THE ELECTRICAL BEHAVIOR OF VARIOUS MAGNETOHYDRODYNAMIC GENERATORS USING EXPLOSIVES. Bernard, Jean; Jouys, Jean-Claude (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Apr. 1969. 86p. (In French). Dep.

The electric behavior of several types of pulse generators which use MHD conversion of chemical energy of explosives to supply experiments of plasma physics is reported. Their electric parameters and behavior on ohmic and inductive loads were studied and compared. The electrical energy which appears on the load is studied in relation to the load and generator characteristics. The way to increase the initial electric energy is pointed out. (auth)

32208 (DLR–MITT–67–17) REPORT ON THE JOINT MEETING OF THE WGLR PROFESSIONAL BOARD OF ENERGY CONVERSION AND ELECTRIC PROPULSION AND PLASMA FLOW, JANUARY 22, 1965 AND APRIL 1, 1966 IN STUTTGART. (Wissenschaftliche Gesellschaft fuer Luft- und Raumfahrt e. V., Brunswick (West Germany)). Oct. 1967. 165p. (In German). (CONF-650124; CONF-660466). Dep.

Topics covered in the 12 papers include: unstationary stagnation point current in magnetogasdynamics, arc discharges in supersonic flow, electrodeless plasma acceleration system with conical discharge coil, spectroscopic measurements on an electrodeless plasma accelerator, plasma propulsion with thermal and magnetic acceleration, supersonic plasma beam with axial flow, a magnetic-field-stabilized high-temperature arc, diagnostics of supersonic plasma beams, aerodynamic measurements on supersonic plasma beams, theory of electric arcs with radial mass injection, heat transfer by argon and nitrogen plasmas to a cold wall, and plasma propulsion cathodes with high currents and low pressurer. (M.C.G.)

32209 (EOS–4018–Q–1) DEVELOPMENT OF THERMIONIC CONVERTERS. First Quarterly Progress Report. Jacobson, Dean (Electro-Optical Systems, Inc., Pasadena, Calif.). [nd]. Contract 952255. 24p.

For Jet Propulsion Lab., Pasadena, Calif.

Progress in a program to design and develop low-power, high-efficiency thermionic converters of cylindrical geometry, capable of being integrated to form a modular power supply, is reviewed. The design, fabrication, and performance of two models of the converter are presented. (M.H.R.)

32210 IMPROVEMENTS IN OR RELATING TO COMPOSITE TUBULAR STRUCTURES AND THE APPLICATION THEREOF TO THERMIONIC CONVERTERS. (to Commissariat a l'Energie Atomique). British Patent 1,152,734. May 21, 1969. Priority date Sept. 17, 1965, France.

A composite tubular structure for the construction of a thermionic converter element such as a plasma diode is described. This structure comprises two coaxial cylindrical cases of heat-resistant metals or alloys. The metal or alloy of the outer case has, at the temperature of use, a greater resistivity than the metal or alloy of the inner case. The two cases are insulated from each other by an electrical-insulating and a heat-insulating intermediate layer consisting of a powdered material such as a heat-resistant oxide, for example, pure alumina or yttrium oxide alumina. (M.H.R.)

32211 MAGNETIC SYSTEMS USING STEEL FOR MAGNETOHYDRODYNAMIC GENERATORS. Bul, O. B. Izv. Vyssh. Ucheb. Zaved., Elektromekh., No. 12, 1333-40(1967). (In Russian).

Magnetic systems for use in magnetohydrodynamic generators which convert thermal energy directly to electric energy are discussed. Design, plasma flow, and magnetic field homogeneity are analyzed for circular, loop, and linear-circular generators (a combination of the first two). Calculations are presented for a circular magnetic system and the results are compared with the basic parameters of a rectilinear magnetic system intended for use in a magnetohydrodynamic generator of the same capacity. It was found that the circular magnetic system requires 30% less copper and the same amount of steel, the squareness of the channel has to be modified to obtain a homogeneous field, and the channel has to be longer. (ATD)

32212 VOL'T–AMPERNYYE KHARAKTERISTIKI TERMOEMISSIONNYKH PREOBRAZOVATELEY. (Volt–Ampere Characteristics of Thermionic Converters). Pyatnitskii, A. P.; Sergeev, D. I.; Nevezhin, O. A. Moscow, Atomizdat, 1967. 150p.

An attempt is made at a systematized approach to methods of electric measurements in the field of direct thermal energy conversion. Among the topics discussed are: basic principles of circuit element selection, calculation methods, and methods for the experimental reading of volt–ampere characteristics. Original engineering methods for analyzing the characteristics of new dc sources are proposed. Also discussed are the switching of low-voltage heavy currents and ways of obtaining stepped-up voltages. 24 references. (ATD)

32213 ENERGY DISTRIBUTION OF ELECTRONS IN A CESIUM THERMIONIC DISCHARGE. Shaw, David Tai-Ko (State Univ. of New York, Buffalo). J. Appl. Phys., 40: 1412-17(May 1969).

The electron energy distribution is obtained for a cesium

plasma in a thin region close to the emitter of an ignited-mode thermionic converter. Assuming that the steady-state plasma is spatially uniform, the Boltzmann equation with only the electric field and the collision terms is solved by the use of WKBJ method. The collision terms include the elastic, inelastic and electron–electron Coulomb interactions. A parameter p which is proportional to the ratio of the degree of ionization and the electric field, is used to characterize the effect of the electron–electron interaction on the energy distribution. The stability of the present solution depends on the position of a singular point, a so-called turning point in the wave equation. The present method gives a stable solution when $p \geq 3$. When $p < 3$, the "turning point" moves inside the inelastic region, and the equation has multivalued solutions. Thus the present method cannot be applied to those cases with very large induced electric field and small degree of ionization. The solution is examined in various values of p, and the effect of nonequilibrium ionization in the energy distribution function is discussed. (auth)

Fluid Physics

32214 (JPRS-48041) SOVIET STUDIES ON MAGNETOHYDRODYNAMIC GENERATORS. Rakhimov, A. T.; Ulinich, F. R.; Yakubenko, A. E. Translated from Conference on Electricity from MHD, Vol. I, held in Salzburg, July 4–8, 1966. 22p. CFSTI.

Translations of two papers are included; abstracts appeared earlier in NSA 20: 41735 and 20: 41779. (M.O.W.)

32215 (MIAPH-AP-68.8) FORCE-FREE HYDROMAGNETIC DYNAMIC STABILITY. Norwood, Joseph Jr.; Wells, Daniel R. (Miami Univ., Coral Gables, Fla. Dept. of Physics). [1969]. 18p. Dep. CFSTI.

The stability of force-free hydromagnetic equilibria is reviewed, and a dynamic solution for force-free fields is derived. It is shown that such a solution is stable if the mass flow is collinear Alfvénic (equipartition). This combination is shown to be the lowest-energy solution of the nonlinear hydromagnetic equations that possesses both finite velocity and magnetic field. The ratio of current density to magnetic flux density is derived on the basis of a general relation for rotation of hydromagnetic fluids with finite Hall effects. (auth)

32216 (SC-M-69-366) ELECTROHYDRODYNAMIC FLOW CONTROL. Stuetzer, Otmar M. (Sandia Labs., Albuquerque, N. Mex.). [1963]. 26p. Dep. CFSTI.

A space charge in a dielectric fluid can severely modify the flow pattern. It is demonstrated at low Reynolds numbers that turbulent flow can be made laminar and boundary layer separation can be prevented. A few theoretical comments are added. (auth)

32217 STEADY ROTATION OF A SPHERE IN A VISCOUS CONDUCTING FLUID. Ranger, K. B. (Univ. of Toronto). J. Phys. Soc. Jap., 26: 1286-90(May 1969).

The flow considered is the steady rotation of a sphere in a viscous fluid of infinite conductivity at rest. The free magnetic field is produced by a magnetic dipole located at the center of the sphere and directed perpendicular to the axis of rotation. The velocity and induced fields are calculated for small values of the Reynolds, magnetic Reynolds, and Hartmann numbers, respectively. The couple on the sphere consists of two parts, the dynamic couple derived from the moments of the viscous forces which increases the couple and a magnetic couple arising from the magnetic stresses in the fluid which tends to decrease it. The total couple is the sum of the dynamic and magnetic couples and is decreased by a term of order M^2 due to the presence of the magnetic field. (auth)

32218 ON THE STEADY FLOW OF A NON-EQUILIBRIUM IONIZED GAS PAST A WALL WITH SHARP CORNERS IN THE PRESENCE OF A MAGNETIC FIELD. Kusukawa, Ken-ichi; Takahashi, Tsuguo (Tokyo Metropolitan Univ.). J. Phys. Soc. Jap., 26: 1291-1300(May 1969).

The steady flow of a nonequilibrium ionized gas past an insulated wall with sharp corners, in the presence of an applied magnetic field is treated by linear approximation. The supersonic aligned-field flow is studied in cases of very low and infinite conductivity. Since the perturbations identically vanish upstream of the first corner, the Laplace transformation can be applied to solve the problem. Pressure, density, and electron number distributions over the wall are obtained. In the crossed-fields case, only the supersonic flow of a very-low conducting gas is studied by the same procedure. In infinite-conductivity flow, the disturbances can propagate upstream through the wall, even if the flow is supersonic. Another method is necessary to deal with such a problem. (auth)

32219 PARALLEL FLOW OF A WEAKLY IONIZED TWO-TEMPERATURE GAS. Shioda, Susumu (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). J. Phys. Soc. Jap., 26: 1301-5(May 1969).

The effects of Joule heating in a parallel flow of a weakly ionized gas between two flat walls are examined by expanding governing equations of the multicomponent gas in power series of the electron Mach number. A parameter is proposed as a relevant quantity which characterizes the "two-temperature" gas. Further, the thermal boundary layer, the electric potential induced perpendicularly to walls, and heat fluxes to walls due to electrons and neutrals are analyzed in detail. (auth)

32220 MAGNETOHYDRODYNAMIC FLOW IN A TUBE OF SQUARE CROSS SECTION IN PRESENCE OF A TRANSVERSE MAGNETIC FIELD. CASE OF CONDUCTING WALLS PARALLEL TO THE MAGNETIC FIELD. Jaumotte, Andre L.; Hirsch, Charles; Troch, Jean-Louis (Univ., Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 54: 838-52(1968). (In French).

The principal theoretical results are given for a rectangular cross section large enough that the flow can be considered as one-dimensional (flow between two insulated parallel plates, an exterior circuit joining the two parallel plates to a magnetic field, the latter being rejected at infinity). Results are given for measurements carried out on a tube with a square cross section of which the two walls perpendicular to the applied field are insulated and the two walls parallel to the same field are conducting. These measurements show: the modification of the pressure gradient at the time of flow; the applied field and the external current variations; and the voltage difference, with the circuit open between the conducting plates, as a function of the flow and of the applied magnetic field. (tr-auth)

32221 ON AN INITIAL BOUNDARY VALUE PROBLEM IN MAGNETOHYDRODYNAMICS. Lassner, Gerd (Karl-Marx-Univ., Leipzig). Arch. Ration. Mech. Anal., 25: 388-405(1967). (In German).

It is pointed out that smooth weak solutions of the first initial-boundary value problem for magnetohydrodynamics, i.e., with the velocity and magnetic field prescribed on the boundary (R. H. Dyer and the reviewer (Arch., 9: 403-10(1962)) are not automatically classical solutions of the magnetohydrodynamic equations; instead they will, in general, satisfy equations with an extra gradient term involved. A similar remark is to be found in Dyer's thesis ("Problems related to the stability of hydrodynamic and magnetohydrodynamic flows," PhD. thesis, University of Wales, Cardiff, 1962). To avoid this difficulty, a modified form of Ohm's law is used; this enables a proof under appropriate conditions of existence and uniqueness to be given, together with some regularity properties. (Math. Rev.)

32222 THE SOLUTION OF TEMPERATURE DEVELOPMENT IN THE ENTRANCE REGION OF AN MHD CHANNEL BY THE B. G. GALERKIN METHOD. LeCroy, R. C. (Lockheed-Georgia Co., Marietta, Ga.); Eraslan, A. H. J. Heat Transfer, 91: 212-20(May 1969).

The general mathematical problem of MHD thermal entrance regions is formulated for a parallel plate channel by including Joule heating, viscous dissipation, and the effect of axial conduction. The associated eigenvalue problem is solved by the B. G. Galerkin method and the results are presented for constant wall temperature and constant wall heat flux conditions. It is shown that the particular method has distinct computational advantages over the classical form of solutions. The constant wall temperature case is investigated by employing the solutions of the eigenvalue problem, and it is concluded that the axial conduction has considerable effect on the temperature development for low values of Peclet number. (auth)

32223 PERIODIC MOTIONS IN MAGNETOHYDRODYNAMICS. Rionero, Salvatore (Univ., Naples). Meccanica, 3: 207-13 (Dec. 1968).

A uniqueness theorem and an existence theorem for motions asymptotically stable in the mean, and periodically depending on time, are demonstrated in magnetohydrodynamics, on the hypothesis that a motion sufficiently regular and asymptotically stable in the mean exists. In particular, similar theorems for steady motions are deduced. (auth)

32224 MAGNETOFLUIDDYNAMIC ATTENUATION OF SOUND IN HIGH-TEMPERATURE NOZZLE EFFLUX. Sepulveda, Jose Alcarez. St. Louis, Washington Univ., 1968. 325p. Thesis.

An entirely new concept of aerodynamic sound suppression called magnetoaerosonics is presented. In brief, the science of magnetoaerosonics utilizes the forces and effects derived from the interactions of an electromagnetic field with a moving, electrically conducting fluid to influence the generation and propagation of pressure waves or sound waves. The foundation of this new concept is built on two important branches of science, namely; aerosonics and magnetofluiddynamics. The first portion, therefore, is concerned with aerosonics and gives the definitions and explanations of the various mechanisms responsible for the conversion of the kinetic energy of a fluctuating fluid flow into the acoustic energy of the oscillating particles at the sound source and in the radiation field. The discussion includes the physical and mathematical descriptions of the elementary models of sound sources, the various mechanisms of sound production and propagation, and the various aerosonic theories. Several sound attenuation schemes are suggested to take advantage of the various attenuation mechanisms in both the generation and propagation phases. In particular, the sound attenuation scheme which calls for the injection of an electrically conducting fluid around the jet exhausts and the application of a magnetic field in the interaction region is most promising. In this scheme the most dominant mechanism is the one which reduces the mean shear through the action of magnetofluiddynamic forces and effects. A detailed study of this important mechanism is made by solving the governing magnetofluiddynamic equations of two interacting, electrically conducting streams in the presence of a transverse magnetic field. The resulting theoretical calculations show that a substantial reduction in sound power can be obtained with a reasonable magnetic field strength and the addition of small amounts of seeding materials (e.g., potassium cesium). Experimental verification of theoretical results is made using a specially built magnetofluiddynamic shear channel with two arc heaters operating on nitrogen supplying the two interacting and electrically conducting streams. Experimental results compare very well with theoretical predictions. (Disser. Abstr.)

32225 EFFECTS OF CONDUCTING WALLS ON HEAT TRANSFER IN MHD COUETTE FLOW. Soundalgekar, V. M. (Indian Inst. Tech., Bombay). Proc. Nat. Inst. Sci. India, Part A, 35: 44-53(Jan. 1969).

The effects of conducting walls on heat transfer in fully developed MHD Couette flow under a transversely applied magnetic field are presented. The temperature is assumed to vary linearly along the walls, and expressions for temperature, Nusselt number, and mean mixed temperature are obtained in closed form. Numerical calculations are presented under the condition of $\Phi_1 < \Phi_2$, where Φ_1 and Φ_2 are the wall electric conductance ratios for the upper and the lower walls, respectively. It is observed that for constant M, P_rRS and Φ_1, an increase in Φ_2 leads to an increase in the fluid temperature, whereas for constant M, P_rRS and Φ_2, an increase in Φ_1 leads to a decrease in the fluid temperature. Under various conditions, temperature profiles are shown graphically and the values of the Nusselt number and mean mixed temperature are presented in the form of a table followed by a discussion. (auth)

32226 STABILITY OF HYDROMAGNETIC FLOW BETWEEN POROUS PARALLEL PLATES UNDER TRANSVERSE MAGNETIC FIELD. Jain, R. K. (Indian Inst. of Tech., Kanpur). Proc. Nat. Inst. Sci. India, Part A, 35: 37-43(Jan. 1969).

Effect of wall porosity is investigated on the stability of hydromagnetic flow between two parallel plates under a uniform transverse magnetic field. It is shown that, for weakly conducting fluids, critical Reynolds number for the onset of instability is lower for two-dimensional disturbances than for three-dimensional disturbances. A class of sufficient conditions is also obtained for stability of the system. (auth)

32227 ON GENERALIZED MHD COUETTE FLOW IN SLIP-FLOW REGIME. Soundalgeker, V. M.; Dhavale, A. T.; Haldavnekar, D. D. (Indian Inst. of Tech., Bombay). Indian J. Phys., 42: 449-59(Aug. 1968).

An analysis of the combined influence of electric and magnetic fields on generalized Couette flow of an electrically conducting, incompressible, viscous fluid is carried out. Closed-form solutions are obtained for velocity, current density, and flow rate under first-order velocity slip conditions. They are shown on graphs. The numerical values of the velocity gradient are entered in a table. (auth)

32228 ELECTROHYDRODYNAMIC RAYLEIGH-TAYLOR BULK INSTABILITY. Turnbull, Robert J. (Univ. of Illinois, Urbana); Melcher, James R. Phys. Fluids, 12: 1160-6(June 1969).

A stability criterion is found for an initially static, stratified fluid subject to an electric stress. The equilibrium fluid density, permittivity, viscosity, and space charge distributions are functions of the vertical spatial coordinate, with gradients directed parallel to the imposed electric field intensity and gravitational acceleration. In the limit where the fluid is perfectly insulating, sufficient conditions for stability are found; the principle of exchange of stabilities is shown, and variational principles derived for the eigenfrequencies and, in the case of no space charge, for the critical field strength. An experiment demonstrates instability in the dielectrophoretic limit of no bulk free charge. The property gradients are induced thermally, and incipience of instability, as measured by the Schmidt–Milverton heat-transfer technique, is successfully predicted by the theoretical criterion. (auth)

32229 INVISCID LAYERS IN MAGNETOHYDRODYNAMICS. Buckmaster, John (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 12: 1173-6(June 1969).

The equations of inviscid magnetohydrodynamics, appropriate when the induced magnetic field can be neglected, are studied when the interaction parameter N is very large. The limit equations, in which the nonlinear inertia terms do not appear, cannot fully describe general inviscid flow situations suggesting the existence of inviscid boundary layers in which the missing terms must be reinstated. Similarity solutions are obtained for two kinds of layers, one perpendicular to the magnetic field and the other parallel to the magnetic field. The parallel layers are backward jets and constitute our most important result. The existence of the perpendicular layers, which look like reversed shock layers, may have implications for flow in ducts with discontinuous area changes. (auth)

Geophysics (Upper Atmosphere)

32230 (N-69-22265) INTERACTION OF THE INTERPLANETARY MEDIUM WITH THE EARTH'S MAGNETOSPHERE IN A PERIOD OF SOLAR ACTIVITY DECREASE. Kovalevskii, N. V. Translated from Geomagn. Aeron., 9: No. 1, 10-13(1969). 9p. (NASA-CR-100826). CFSTI.

Daily and 3-hourly values (in the plane of the magnetic equator) are computed of the position of the magnetopause, of the bow shock wave, of the thickness of the transitional region near the subsolar point, and of the field of magnetopause currents on the Earth's surface. (auth) (STAR)

32231 IMPLICATIONS FOR IONOSPHERIC CHEMISTRY AND DYNAMICS OF A DIRECT MEASUREMENT OF ION COMPOSITION IN THE F2 REGION. Brinton, H. C.; Pharo III, M. W.; Mayr, H. G.; Taylor, H. A. Jr. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 2941-51 (June 1, 1969).

The positive ion mass spectrometer on the Geoprobe (NASA 8.25) rocket measured the concentrations of O^+, N^+, H^+, He^+, NO^+, O_2^+, and N_2^+ between 200 km and peak altitude, 630 km, at 1300 EST on March 2, 1966, above Wallops Island, Virginia. The dominant ion throughout the altitude range was O^+, with a maximum concentration of 5×10^5 ions/cm^3 at 260 km. The first detection of H^+ occurred at 230 km, its concentration increasing to 7×10^3 ions/cm^3 at peak altitude. The H^+/He^+ ratio was never lower than 6.0, the value at 420 km. The molecular ions NO^+ and O_2^+ were important constituents at 200 km, the concentration of each being 5×10^4 ions/cm^3; they fell off rapidly above this altitude. Photochemical equilibrium held for He^+ up to 400 km with a rate coefficient of about 0.5×10^{-9} cm^3 sec^{-1} for charge transfer with N_2, in agreement with laboratory measurement. Charge exchange equilibrium of H^+ with O^+, O, and H held up to 350 km; the temperature derived for the neutrals below 350 km, where it is believed that $T_g = T_i$, was 850°K, which agrees with T_g measured by companion neutral particle sensors. From the variation of $[H^+]/[O^+]$ and an [O] distribution based on a simultaneous EUV measurement, a profile of [H] in the chemical equilibrium region was calculated. The derived H concentrations are higher than the Jacchia 1964 Model predictions, but agree with Explorer 32 spectrometer results. Analysis indicates that N^+ was not in diffusive equilibrium at 300 km, and that a neutral wind having a field-aligned downward component of 25 m/sec is required to produce the observed N^+ scale height at this altitude. Distributions of O^+ and H^+ above 300 km were derived by solving the continuity equations along field lines; an upward H^+ flux of 1.5×10^8/cm^2 sec was required to reproduce the observed profiles, indicating that the critical flux is at least an order of magnitude higher than previously believed. (auth)

32232 GEOMETRIC PARAMETERS AND TEMPERATURE OF THE F1 LAYER DURING THE IGY AND IQSY. Shapiro, B. S.; Freyzon, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and

Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 895-6(1968).
Translated from Geomagn. Aeron., 8: 1105-7(1968).

The average variations in the height of the ionization maximum of the layer, F1-h_{max}F1, and the thickness parameter, q_cF1, were computed for the IGY and IQSY summer from observations at Moscow. The hourly N(h) profiles were analyzed by machine computations using the normal integral method from observations on Regular World Days (RWD) and on some other selected quiet days. The h_{max}F1 and q_cF1 values were computed by a parabolic approximation of N(h) in the vicinity of the F1-layer maximum. (W.D.M.)

32233 ANALYTICAL DESCRIPTION OF THE SPACE–TIME VARIATIONS OF f_0 F2. Vazarzhapov, A. D.; Chernyshev, O. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 897-8(1968).
Translated from Geomagn. Aeron., 8: 1108-9(1968).

In 1968 the authors reported the development of a method for the analytical description of the planetary distribution of f_0F2. According to this method, the space distribution of the critical F2-layer frequency at a fixed instant of universal time is written in the form of a series. This method is developed further and applied to more extensive data. (W.D.M.)

32234 INFLUENCE OF AERONOMIC PARAMETERS ON THE IONOSPHERIC EFFECT OF AN SC MAGNETIC STORM. Shashun'kina, V. M.; Shapiro, B. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 899-901(1968).
Translated from Geomagn. Aeron., 8: 1100-3(1968).

The N(h) parameters in the ionosphere change briefly after an SC magnetic storm. The delay of this effect is identified with the propagation of internal gravity waves in the F2 layer that appear at the instant of the SC at latitudes Φ = 60 to 65°. The rate of propagation of the effect and its period vary with the time of the day and activity, and these variations are closely associated with the N(h) parameters. The results of further investigations of the reaction of the ionosphere to the propagation of gravity waves after an SC and of the response of the aeronomic parameters of the ionosphere to conditions of propagation of these waves are reported. (W.D.M.)

32235 f_0E_s DISTRIBUTION CURVES. Chernyshev, O. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 902-3(1968).
Translated from Geomagn. Aeron., 8: 1114(1968).

The development of a method for the analytical description of the space-time variations of the monthly median f_0F2 values has been reported previously. It was demonstrated that the approximation error lies within 6 to 7%, which is quite acceptable. In this note, the method is applied to an analytical description of the space–time variations of the E_s-layer parameters. (W.D.M.)

32236 SOME CHARACTERISTICS OF THE EQUATORIAL IONOSPHERE OBSERVED OF THE SCHOONER ZARYA. Pogrebnoi, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 903-4(1968).
Translated from Geomagn. Aeron., 8: 1115(1968).

Two problems are examined on the basis of the ionospheric data collected on the schooner Zarya: the frequency of occurrence of spread F and the characteristics of the E_s layer in the equatorial region. (W.D.M.)

32237 SPORADIC E-LAYER. Kosikov, K. M. Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 904-5(1968).
Translated from Geomagn. Aeron., 8: 1116(1968).

Two ionospheric stations equipped with various instruments operated for several years, starting with the 1940's, near Moscow. Various measurements and results from these stations are reviewed. (W.D.M.)

32238 VARIABILITY OF S_q VARIATIONS. Zaitsev, A. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 905-6(1968).
Translated from Geomagn. Aeron., 8: 1117(1968).

Proceeding from the wave nature and the dynamo mechanism of the formation S_q variations, a simple model to explain their variability is examined. It is assumed that the geomagnetic field is a dipole field whose axis crosses the center of the Earth and forms an angle of ~10° with the axis of rotation of the Earth. (W.D.M.)

32239 VARIABILITY OF S_q VARIATIONS IN THE SOLAR ACTIVITY CYCLE. Pogrebnoi, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 906-7(1968).
Translated from Geomagn. Aeron., 8: 1118-19(1968).

The dependences of r_H [mean annual diurnal amplitude of $S_q(H)$] on the relative sunspot number in different latitudinal zones were examined and compared with the f_0E variations in the solar activity cycle, since there are indications of a close correlation between the changes in S_q variations and ionization in the ionospheric E layer. (W.D.M.)

32240 REFERENCE FIELD LEVEL IN THE COMPUTATION OF S_q VARIATIONS. Zaitsev, A. N.; Fel'dshtein (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 908-10 (1968).
Translated from Geomagn. Aeron., 8: 1120-2(1968).

The quiet solar–diurnal variation, S_q, is taken as the reference level in the study of various types of disturbed magnetic fields. Numerous studies on the problem of the reference level of S_q are briefly reviewed. (W.D.M.)

32241 11-YEAR GEOMAGNETIC ACTIVITY CYCLE, ACCORDING TO THE DATA OF SVERDLOVSK MAGNETIC OBSERVATORY FOR 1943 TO 1966. Panov, T. N. (Inst. of Geophysics, Ural, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 910-12(1968).
Translated from Geomagn. Aeron., 8: 1123-4(1968).

The 11-year geomagnetic activity cycle and the variability in the cycle of the amplitudes of solar–diurnal geomagnetic variations on quiet days are examined on the basis of data from Sverdlovsk Observatory for 1943–1966. The geomagnetic data are compared with the Wolf numbers for 1943–1946 and with the reports of the Main Astronomic Observatory of the USSR Academy of Sciences for 1947–1965. (W.D.M.)

32242 SEPARATION OF THE SPACE AND TIME VARIATIONS OF THE MAGNETIC FIELD, ACCORDING TO OBSERVATIONS ON DRIFTING STATIONS. Galkin, R. M. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 912-13(1968).
Translated from Geomagn. Aeron., 8: 1125-6(1968).

Variation records made on drifting ice show variations of the constant field, associated with the continuous changes in the position of the stations, along with time variations. The variations of the constant field can be separated by applying the method of moving averages to the observed average hourly values. The effectiveness of the method was investigated on the basis of individual observations in the central Arctic. (W.D.M.)

32243 NONLINEAR RESONANCE FOR MODULATED RADIO WAVES IN A PLASMA (IONOSPHERE). Gurevich, A. V.; Shvartsburg, A. B. (Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 893-4 (1968).
Translated from Geomagn. Aeron., 8: 1104(1968).

It is demonstrated that resonance interaction between amplitude-modulated radio waves and a plasma in a constant magnetic field is possible. As an example, an extraordinary wave propagating perpendicularly to the magnetic field is examined. (W.D.M.)

32244 CHARACTERISTIC PROPAGATION VELOCITIES OF WEAK DISTURBANCES IN THE INTERPLANETARY MEDIUM AND MACH NUMBERS DURING THE PERIOD OF DECREASING SOLAR ACTIVITY. Kovalevskii, I. V. (Inst. of Terrestrial Magnetism, Ionosphere and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 807-11(1968).
Translated from Geomagn. Aeron., 8: 1003-7(1968).

Mariner 2 data for a period of decreasing solar activity are used to investigate the acoustic, Alfvén, and magnetoacoustic velocities of propagation of weak disturbances and their corresponding Mach numbers over a long period of time. It is shown that these parameters vary substantially. Estimates are given of the speed of reconnection of the magnetic lines of force of the interplanetary and geomagnetic fields. (auth)

32245 RADIO WAVE SCATTERING IN AN INHOMOGENEOUS IONOSPHERE. Vas'kov, V. V. (Inst. of Terrestrial Magnetism, Ionosphere and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 818-23(1968).
Translated from Geomagn. Aeron., 8: 1014-20(1968).

Radio wave scattering on an electron concentration disturbance in the vicinity of the reflecting layer of the ionosphere is computed. Consideration is given to forward and backscatter. The vertical inhomogeneity of the ionosphere is taken into account on the assumption that the magnetic field has no effect on radio wave propagation. (auth)

32246 TOPOLOGY OF THE DRIFT SHELLS OF PARTICLES IN THE MAGNETOSPHERE. Shabanskii, V. P.; Antonova, A. E. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 799-802(1968).

Translated from Geomagn. Aeron., 8: 993-7(1968).

The magnetic drift shells of trapped particles are computed. The zones where the particles are quasi-trapped and from which they cross the boundary of the core, i.e., the region of closed lines of force, are determined. A peculiarity is noted in the behavior of magnetic drift shells distant from the Earth: in addition to being split in pitch angles, the shells also separate into two branches on the day-light side and these branches extend into the northern and southern hemispheres so that a doubly connected surface forms. (auth)

32247 SOME CHARACTERISTICS OF THE FIELD OF RADIO WAVES UPON DIFFRACTION ON A REGULAR PHASE SCREEN. Vinogradova, M. B. (Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 824-6(1968).

Translated from Geomagn. Aeron., 8: 1021-4(1968).

The properties of the amplitude, phase, and phase velocity of a wave that has crossed a regular (sine), deep-phase screen are analyzed. The properties of a regular and a random-phase screen are compared. The possibility of explaining some patterns of rapid amplitude and phase variations of a field scattered by the ionosphere on the basis of a model of a deep quasi-periodic phase screen is discussed. (auth)

32248 POLARIZATION OF SCATTERED ELECTROMAGNETIC WAVES. Gusev, V. D.; Berezin, Yu. V.; Biryulin, I. A. (Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 827-31(1968).

Translated from Geomagn. Aeron., 8: 1025-30(1968).

The polarization of radio waves scattered by small-scale ionospheric inhomogeneities is examined. The distributions of the modulus and argument of the polarization factor and the ratios of the half-axes and of the angle of rotation of the polarization ellipse are obtained and analyzed. (auth)

32249 TRANSFORMATION OF THE ELECTRIC FIELD DURING THE PROPAGATION AND TRANSITION OF AN ACOUSTIC WAVE INTO PLASMA WAVES. Nikolaev, Yu. M. (Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 832-8 (1968).

Translated from Geomagn. Aeron., 8: 1031-8(1968).

The theory of excitation of electric fields during the nearly vertical upward propagation of an acoustic wave at the heights of the ionospheric F layer is examined. The arising charge separation results in the transformation of the electric field into a circularly polarized wave. The transformation of the electric field with height in such a wave is investigated. A system of plasma equations is proposed which allows for the motion of neutral particles, which is given in the form of a propagating viscous acoustic wave. The conclusions of the theory are used to interpret patterns that are associated with the nature of the propagation of electric fields. An estimate is given of the efficiency of formation of inhomogeneities with allowance for the relationship of the concentration of electrons and ions with height. (auth)

32250 ESTIMATES OF THE VERTICAL TRANSPORT VELOCITY OF CHARGED PARTICLES IN THE TOPSIDE IONOSPHERE. Muradov, A.; Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 839-43(1968).

Translated from Geomagn. Aeron., 8: 1039-44(1968).

A method is proposed for determining the effective transport velocity of charged particles in the ionosphere with allowance for vertical velocity gradients. An analytical expression is obtained for the vertical transport velocity of ionization for various forms of the N(h) distribution. Numerical estimates are made of the vertical transport velocity of ionization, w, in the upper part of the ionospheric F2 region under nearly steady conditions ($\partial N/\partial t = 0$). It is demonstrated that at heights <350 km ambipolar diffusion at a rate of about several m/sec cannot provide the vertical transport velocities needed for the experimental N(h) curve to agree with the information available on the structural parameters of the upper atmosphere, short-wave solar radiation, and ionization–recombination processes. Combined analysis of ambipolar diffusion and plasma motions arising during wind motions of the upper atmosphere makes it possible to obtain w values that agree with the values estimated from N(h) profiles. (auth)

32251 DETERMINATION OF THE PARAMETERS OF ELECTRON FLUXES IN POLAR REGIONS FROM SYNCHRONOUS PHOTOMETRIC AND RIOMETRIC OBSERVATIONS. Osipov, N. K.; Pivovarova, N. B.; Pivovarov, V. G. (Inst. of Cosmophysical Investigations and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 844-7(1968).

Translated from Geomagn. Aeron., 8: 1045-8(1968).

The possibilities of determining the energy spectra of electron fluxes from photometric and riometric observations are examined. Relationships are obtained between the emission intensity in the 3914 Å line and cosmic noise absorption for various energy spectra of electron fluxes responsible for polar disturbances. (auth)

32252 CHARACTERISTICS OF WHISTLERS IN CENTRAL EUROPE DURING A SOLAR ACTIVITY MINIMUM. Jiricek, F. (Geophysical Inst., Rez, Czech.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 848-53(1968).

Translated from Geomagn. Aeron., 8: 1049-55(1968).

The characteristics of whistlers recorded at Panska Ves station during the solar activity minimum of 1965 are described. The data obtained are discussed from the point of view of their subsequent use for the systematic determination of electron concentration in the magnetosphere. (auth)

32253 INFLUENCE OF THE RING CURRENT ON THE POSITION OF THE AURORAL OVAL. Starkov, G. V.; Fel'dshtein, Ya. I. (Polar Geophysical Inst., Kola, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 854-8(1968).

Translated from Geomagn. Aeron., 8: 1056-62(1968).

The change in the auroral oval with intensifying D_{st} variation around midnight is examined for fixed DP values. As D_{st} intensifies, the boundary of the oval and its central line shift toward the equator. The position of auroras during the magnetic storm of February 11, 1958, with a very intense ring current is investigated. (auth)

32254 ANALYSIS OF COSMOS-92 AIRGLOW OBSERVATIONS. Krasnopol'skii, V. A. (Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 859-62(1968).

Translated from Geomagn. Aeron., 8: 1063-8(1968).

Two components are distinguished in the airglow burst observed on Cosmos 92: one represents a proportional increase of all the ordinary components of airglow and the other apparently includes a γ system of NO lines and a corresponding emission. The possible source of these emissions is discussed. (auth)

32255 AN EXPERIMENT IN THE USE OF SATELLITE DATA FOR THE STUDY OF SECULAR VARIATIONS. Kolomiitseva, G. I.; Tyurmina, L. O. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 863-6(1968).

Translated from Geomagn. Aeron., 8: 1068-71(1968).

It is demonstrated that it is possible, in principle, to compute secular variation by comparing entirely different kinds of surveys. Use is made of Cosmos 49 measurements of the absolute value of the total geomagnetic field vector, the results of marine and aeromagnetic surveys, and of measurements on Vanguard 3. The δT values obtained are compared with values at nearby observatories. The results of the comparison give reason to hope that similar computations made at locations distant from observatories with allowance for diurnal variations and the anomaly of the regions would yield more definite ideas on the global pattern of secular variation. (auth)

32256 CONTRIBUTION TO THE THEORY OF POLAR STORMS. Pudovkin, M. I.; Shumilov, O. (Leningrad State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 867-71(1968).

Translated from Geomagn. Aeron., 8: 1072-7(1968).

Equations of motion of charged particles in crossed fields, i.e., the homogeneous electric and magnetic dipole fields, in the magnetosphere are integrated numerically. The position of the auroral zone, the diurnal pattern of the azimuths of auroral arcs, the energy of injected particles, and the rate of motion of electrons and protons along auroral arcs are computed. The results obtained agree with experimental data. (auth)

32257 RELATIONSHIP BETWEEN IRREGULAR GEOMAGNETIC FIELD PULSATIONS AND THE PULSATIONS OF AURORAS AND OF VLF EMISSION. Troitskaya, V. A.; Kleymenova, N. G.; Raspopov, O. M.; Geller, L. A.; Roldugin, V. K.; Vigneron, J.; Karchevskii, Zh.; Loran, J. (Leningrad State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 872-4(1968).

Translated from Geomagn. Aeron., 8: 1078-82(1968).

The types of rapid irregular pulsations, closely associated with subsequent chorus excitation, are determined from the results of observations at Sogra on geomagnetic micropulsations, vlf emission, and pulsating auroras. (auth)

32258 SEPARATION OF THE NORMAL GEOMAGNETIC FIELD BY THE MOVING AVERAGE METHOD ON PROFILES OF

FINITE LENGTH. Roze, E. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Leningrad). Geomagn. Aeron. (USSR)(Engl. Transl.), 8: 875-9(1968).
Translated from Geomagn. Aeron., 8: 1083-8(1968).

Errors arising when the moving average method is used to separate the normal geomagnetic field are examined. It is suggested that the necessary averaging interval be selected by the method proposed by Simonenko and Roze (1967). The separation of the normal field on a profile from the data collected by the schooner Zarya in the Pacific is analyzed as an example. Mention is made of the need to allow for the influence of the statistic inhomogeneity of the anomalous field. (auth)

32259 ATTEMPT TO DISTINGUISH BETWEEN vlf EMISSIONS DURING THE DAY AND NIGHT BY MEANS OF THE MAGNETIC ACTIVITY. Taillineau, Yves; Vigneron, Jacques; Kleimenova, Natalia (Groupe de Recherches Ionospheriques, Val-de-Marne, France. Inst. of Physics and the Atmosphere, Moscow. Faculte des Sciences, Poitiers, France). Compt. Rend., Ser. B, 268: 949-52(Mar. 31, 1969). (In French).

A distinction between the vlf emissions during the morning and the evening is established by studying the width of their spectrum in the same way as the condition for their appearance is a function of the variations of the index K_p. Application of these results is made to the storm times. (tr-auth)

32260 ANALYSIS OF COUPLING PROBLEMS IN THE CASE OF PROTON WHISTLERS. Cory, Haim (Groupe de Recherches Ionospheriques, Val-de-Marne, France); Quemada, Daniel; Vigneron. Compt. Rend., Ser. B, 268: 985-8(Apr. 9, 1969). (In French).

An analysis by numerical integration was made of the coupling between the two modes of propagation in the ionosphere: electron and proton whistlers. The first results show the interest in the method used which permits determination of the coupling coefficients between the two modes. (tr-auth)

32261 DIRECT D-LAYER REFLECTION AS A FACTOR IN OBLIQUE PROPAGATION ON THE LOWER HIGH FREQUENCIES. Bain, W. F.; Buckley, R. J. (Page Communications Engineers, Inc., Washington, D. C.). Radio Sci., 4: 419-30(May 1969).

Recently available D-region profiles are used to determine a model in which direct D-region reflection is assumed to be the dominant daylight mode in the 2- to 5-MHz region. This model is applied to the calculation of daylight absorption as a function of frequency and path length at oblique incidence. Good agreement with measurement is found, in contrast to early absorption calculation techniques, which show discrepancies of up to 50 decibels in this frequency range. Evidence suggesting direct D-region reflection higher in the hf band is presented. (auth)

32262 THE SIMPLE THIN-FILM OPTICAL METHOD IN ELECTROMAGNETIC WAVE PROPAGATION. Altman, C.; Cory, H. (Technion-Israel Inst. of Tech., Haifa). Radio Sci., 4: 449-57(May 1969).

Ionospheric transmission and reflection coefficients for vertical incidence are determined by means of a simple and rapid numerical method based on thin-film optics. By this method the ionosphere is divided into a large number of thin layers, all partial reflections within a given layer are summed, and the process is then extended layer by layer to include the entire ionospheric region. The iterative procedure in its simplest form is started high in the ionosphere and extended downward to terminate at the ionospheric base, but by suitable modification it may be started low in the ionosphere and extended upward to yield in a single "run" the contribution of each portion of the electron density profile to the overall reflection and transmission coefficients. The method is free of the tendency to numerical swamping and is valid as long as the wave polarization remains constant, which is true in the D region in most of the vlf range. Comparison with full-wave analysis shows that the method breaks down at higher frequencies when weak coupling processes between the magnetoionic modes become relatively important to varying wave polarizations. (auth)

32263 A QUASI-OPTICAL METHOD FOR CALCULATING PROPAGATION OF LF RADIO WAVES IN THE PRESENCE OF AN IONOSPHERE WITH HORIZONTAL GRADIENTS. PART I. RAY THEORY FOR LOSSY MEDIA, PART II. DIFFRACTION BY THE EARTH. Jones, Richard Michael. Boulder, Colo., Univ. of Colorado, 1968. 158p.
Thesis.

An extension of ray theory is presented by which reflection of lf (30 to 300 kHz) radio waves from the ionosphere can be satisfactorily calculated. This extension uses the complex refractive index (instead of just the real part) in Snell's law to calculate the ray path. In effect, this includes ionospheric losses in determining the ray path, which are very important in the D region, where lf waves are reflected. Although the resulting ray paths, being in complex space, have less physical interpretation, they give accurate results. An accompanying approximation which compensates for the ray's missing the receiver is essential for ray tracing in complex space, but would also be very useful in ordinary ray tracing. J. B. Keller's quasi-optical "geometrical theory of diffraction" represents diffraction by the earth of rays which travel along the ground. These diffracted rays, which are ordinary ground wave modes excited by a sky wave, can be represented more accurately by rays which travel at certain complex heights above the ground. By taking into account all the rays diffracted by the earth and reflected from the ionosphere, it is possible to calculate satisfactorily multi-hop propagation between the earth and ionosphere. Regarding caustics as equivalent to sources permits calculating the excitation of the ground wave by a caustic in the incident field (which nearly always occurs in waves reflected from the ionosphere). Even for a concentric ionosphere, the calculations are simplified by using ray tracing in complex space and the geometrical theory of diffraction. (Disser. Abstr.)

32264 LOW FREQUENCY ELECTROSTATIC INSTABILITIES IN THE MGNETOSPHERE AND THEIR CONSEQUENCES. Liu, Chuan-sheng. Berkeley, Univ. of California, 1968. 114p.
Thesis.

The stability of the Van Allen belt in the outer trapping zone ($2 < L < 8$) against electrostatic low-frequency perturbations is studied. Inside the plasmapause, the energetic belt ($E > 40$ keV) is found to be stable. Outside the plasmapause, the ring-current belt is found to be unstable when the density gradient at the outer edge exceeds a certain critical value. A component of the electric field along the magnetic field line is associated with the instability. When the ring-current belt is stable by itself, it supports a wave which can resonantly interact with the drift motion of the energetic particles. The condition for over-stability is derived. The possible relevance of the instabilities to auroral phenomena is discussed. (Disser. Abstr.)

Low-Temperature Physics

Refer also to abstracts 32585 and 32802.

32265 (BNL-50138) THERMAL CONDUCTIVITY AND VISCOSITY OF HELIUM AT LOW TEMPERATURES. Lindauer, George C. (Brookhaven National Lab., Upton, N. Y.). Sept. 1968. 12p. Dep. CFSTI.

The Enskog method was used to calculate the thermal conductivity and viscosity of helium at temperatures from 4° to 20°K and at pressures from 10 to 30 atm. The calculated viscosities are expected to be valid throughout the entire range of temperatures and pressures studied. The calculated thermal conductivities are expected to be valid throughout the range of temperatures and pressures except in the vicinity of the critical density. In this region, conductivities will probably be substantially higher. (auth)

32266 (CERN-69-9) PHENOMENOLOGICAL ASPECTS OF SUPERCONDUCTIVITY. Lectures given in the Academic Training Programme of CERN, 1967-1968. Muller, Jean (European Organization for Nuclear Research, Geneva (Switzerland)). May 5, 1969. 61p. Dep.

The following subjects are covered: London's electromagnetic description, properties of flux and fluxoid, thermodynamical properties, the Ginzburg-Landau phenomenological description (Type-II superconductors), state of a superconductor between H_{c1} and H_{c2}, results of the microscopic theory of superconductivity (Bardeen-Cooper-Schrieffer theory), superconducting materials, A_3B compounds (the Friedel-Labbe Model), and technological problems. 23 references. (M.H.R.)

32267 (INR-1030) HELIUM CRYOSTAT FOR MOESSBAUER EXPERIMENTS. Piekoszewski, J.; Rolke, Z.; Suwalski, J. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 10p. (In Polish). Dep.

A metallic helium cryostat for Mössbauer experiments carried on in transmission geometry is described. The results of testing experiments on external regulation of the temperature of the sample and the Moessbauer pattern of $Y_3Fe_5O_{12}$ obtained at 5°K are also presented. (auth)

32268 (ORNL-tr-1979) OPTICAL OBSERVATION OF LOSSES OF A SUPERCONDUCTOR IMMERSED IN LIQUID HELIUM. Colombeau, M.; Le Tiran, E.; Mailfert, A. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Rev. Phys. Appl., 3: No. 1, 18-20(Mar. 1968). 4p. Dep. CFSTI.

An abstract of the original French article appears as NSA 22: 29414. (L.M.T.)

32269 THE BEHAVIOR OF ELECTRIC CURRENTS AND MAGNETIC FIELDS IN NONIDEAL TYPE II SUPERCONDUCTORS: LONGITUDINAL CASE. Belanger, Brian Charles. Los Angeles, Univ. of Southern California, 1968. 249p.

Thesis.

The results of an extensive investigation of the behavior of electric currents and magnetic fields in wire samples of nonideal type II superconductors in applied fields parallel to the sample axis and the conduction current are reported. Many authors have studied the transverse case (induced and conduction currents perpendicular to the applied field) which is applicable to high field magnet technology. Due to this emphasis the longitudinal case has been largely neglected. Nb_3Zr was chosen for study in detail since this material is widely used in magnet technology and has been thoroughly explored in transverse fields. A parallel study with NbTi samples was carried on, comparable in all appropriate parameters to determine which phenomena were peculiar to Nb_3Zr and which were characteristic of nonideal type II superconductors in general. (TSS) (Disser. Abstr.)

32270 TECHNOLOGY OF LIQUID HELIUM. Kripschot, R. H.; Birmingham, B. W.; Mann, D. B. (eds.). National Bureau of Standards Monograph 111. Washington, D. C., National Bureau of Standards, 1968. 380p. GPO $2.00.

Information is presented on helium resources, production, conservation, thermodynamic properties, liquefaction and refrigeration techniques, transportation and storage of liquid, and safety requirements. Uses for liquid and cold gas in cryoelectronics, superconductivity, bubble chambers, cryopumping, and missile and space systems are discussed. Articles are included by noted authorities in cryogenic technology in which they discuss their specialized field in great depth. (auth)

32271 FIELD PENETRATION IN A SEMI-INFINITE TYPE-I SUPERCONDUCTOR. Ebner, C. (Faculte des Sciences, Orsay, France); Milleron, P. F. Phys. Rev., 179: 447-9 (Mar. 10, 1969).

The intermediate-state configuration of a thick type-I superconducting slab in the presence of a current-carrying wire parallel to its surface is explored both theoretically and experimentally. Within the experimental error the agreement is satisfactory. (auth)

32272 DIRECT OBSERVATION OF QUANTIZED MAGNETIC FLUX IN A SUPERCONDUCTING HOLLOW CYLINDER WITH AN ELECTRON INTERFEROMETER. Lischke, B. (Univ., Berlin). Phys. Rev. Lett., 22: 1366-8(June 23, 1969).

Quantized magnetic flux trapped in hollow superconducting lead cylinders of extremely small dimensions (0.6 μ ID, film thickness $\leq$0.5 μ, length 100 μ) was observed in an electron interferometer. The flux was found to be quantized in integer multiples of h/2e $\pm$4%. No influence of the size of the tube upon the fluxoid quantum has been observed. (auth)

32273 VOLTAGE DUE TO THERMAL NOISE IN THE dc JOSEPHSON EFFECT. Ambegaokar, Vinay (Cornell Univ., Ithaca, N. Y.); Halpern, B. I. Contract No. N0014-67-A-0077-0010. Phys. Rev. Lett., 22: 1364-6(June 23, 1969).

The effects of thermal fluctuations on the dc Josephson effect in a junction of small capacitance are calculated using an analog with the Brownian motion of a particle in a field of force. The results are presented in a form suitable for comparison with experiment. (auth)

32274 HEAT TRANSPORT IN SUPERFLUID HELIUM IN WIDE TUBES. Critchlow, P. R.; Hemstreet, R. A. (Air Reduction Co., Inc., Murray Hill, N. J.). J. Appl. Phys., 40: 2675-7(May 1969).

The heat transport properties of columns of superfluid helium were explored. The measurements were made in three pipe sizes, nominally 1, 2.8, and 10 mm dia, each 200 cm in length. The results indicated that the relation between heat flux and temperature gradient is approximately cubic. It is concluded that the Gorter–Mellink constant A shows no significant geometrical dependence and that no advantage is gained by using many small tubes instead of one large one, the total area being the same in each case. (M.H.R.)

32275 INVESTIGATION OF QUADRUPOLE EFFECTS OF SECOND ORDER IN THE INTERMETALLIDE V_3Si. Trat'yakov, B. N.; Kuritsyn, V. B. JETP Lett. (USSR) (Engl. Transl.), 9: 67-8(Jan. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 117-19(Jan. 20, 1969).

The character of the tensor of the electric field gradient (TEFG), for the purpose of clarifying the cause of the high temperature of the superconducting transition of V_3Si is of definite interest. The nuclear magnetic resonance of ^{51}V in V_3Si in fields from 2 to 9 kOe was investigated at three temperatures (78, 200, and 300°K). It was observed that in a field of 9 kOe the form of the resonant absorption corresponds to a case typical of quadrupole splitting of first order; the dependence of this quadrupole splitting on the temperature and magnetic field intensity was not observed. When the magnetic field is decreased, the central component of the resonant absorption first broadens, then splits into two equal peaks. Analysis of the date shows that the quadrupole effects of second order are responsible for the observed broadening and splitting. According to the theory of quadrupole effects of second order for an axially symmetric TEFG, the magnitude of the splitting of the central component at 2 kOe should amount to 47 kHz, but experimental results showed only 23 kHz. In addition, the shape of the resonant absorption does not correspond to the theoretically expected one. Therefore, it is concluded that there is no axial symmetry of the TEFG at the locations of the vanadium nuclei in V_3Si. The Knight shift determined from this investigation was independent of field strength and showed good agreement with earlier results at a field strength of 14 kOe. (L.M.T.)

32276 ^{3}He AND ^{4}He. Keller, William E. The International Cryogenics Monograph Series. New York, Plenum Press, 1969. 341p. $18.50.

The results of important experiments on He at low temperatures are described. Considered from a background of recent theoretical views, the properties of familiar "classical" systems are compared with those of ^{3}He and ^{4}He and it is shown how quantum effects account for the differences. Comparing ^{3}He and ^{4}He, it is demonstrated, using quantum mechanics, how the differences in mass and particle statistics explain the dissimilarities between these two isotopes. (M.H.R.)

32277 MEASUREMENTS OF ENERGY LOSSES IN PULSED SUPERCONDUCTING MAGNETS. Morgan, G. H.; Dahl, P. F.; Sampson, W. B.; Britton, R. B. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 40: 1821-9(Mar. 15, 1969).

Measurements have been made of ac power losses in a number of small superconducting magnets. The losses were determined by the volume of helium vaporized. The magnets had inductances from 1.4 to 47 mH and were wound with commercially available, half-inch wide, partially stabilized Nb_3Sn ribbon. They were powered by sawtooth current pulses of 1 to $\frac{1}{20}$ Hz, similar to those of a proton synchrotron and also by sinusoidal current waveforms of 60 Hz. Peak currents ranged from 1 to 1100 A and the corresponding peak fields from about 500 to 50,000 G. It is found that at low frequencies, loss per cycle is independent of frequency. It is also found that at low frequencies and moderate fields, the loss depends only on the total field change and is largely independent of current or of steady components of field. Losses measured at 60 Hz and low fields are in agreement with these low-frequency results where the data overlap. Losses obtained from magnets of different geometries can be correlated on the basis of the average component of peak field normal to the ribbon surface. Losses at high fields are quite dependent on winding density, which is attributed to a diamagnetic or field-exclusion effect. They increase with Nb_3Sn content at high fields, but tend to be independent of Nb_3Sn content at low fields. Losses vary approximately as the 2.5 power of the change in field. The ratio of energy stored to energy dissipated is about the same in all magnets in moderate to high fields. The results are compared with theory and with those of other experimenters. (auth)

32278 NORMAL-STATE SPECIFIC HEAT OF NIOBIUM–TANTALUM ALLOYS. Kimura, Y. (Tokyo Univ.); Ohtsuka, T.; Matsui, T.; Mizusaki, T. Phys. Lett., 29A: 284-5 (May 19, 1969).

Low-temperature specific heat measurements on Nb–Ta alloys up to 40 at. % Ta were performed. The electronic specific heat coefficient behaves anomalously and shows a maximum at around 6 at. % Ta in contrast to the Debye and superconducting transition temperatures which both decrease monotonically with addition of Ta to Nb. (auth)

32279 HARD SUPERCONDUCTORS. Ullmaier, H. (Kernforschungsanlage, Juelich, Ger.). Z. Angew. Phys., 26: 261-76(1969). (In German).

Since the discovery of their high critical current and magnetic field in 1961, hard superconductors claim a steadily increasing scientific and technical interest. The physical principles of these materials are discussed. The properties of ideal type II superconductors which are the basis of hard superconductors are described, followed by a more detailed account of the interaction of magnetic flux lines (vortices) with structural defects (pinning centers). Pinning forces arising from these interactions are the necessary condition for the high-supercurrent-carrying capacity

of hard superconductors. The influence of transport currents and the possible reasons for magnetic instabilities are dealt with. A short survey over the problems of building superconducting coils for high magnetic fields is given. (auth)

32280 LINE SHAPE OF BRILLOUIN LIGHT SPECTRUM IN ^{3}He–He II SYSTEM. Ganguly, B. N. (Louisiana State Univ., Baton Rouge). Phys. Lett., 29A: 234-5(May 19, 1969).

The line width of the Brillouin light spectrum of ^{3}He–He II system due to first sound, second sound, and central diffusion peaks are calculated. (auth)

32281 2 e/h BY THE AC JOSEPHSON EFFECT. Petley, B. W.; Morris, K. (National Physical Lab., Teddington, Eng.). Phys. Lett., 29A: 289-90(June 2, 1969).

2e/h has been measured using drop junctions at 36.8 GHz. The result is 0.2 ppM higher than the value of Parker et al. and the value obtained is $2e/h = 483.5939_3 \pm 0.0010$ (2.2 ppM) MHz/$\mu V_{NPL(1969)}$ or 483.5936 ± 0.0011 (2.2 ppM) MHz/$\mu V_{BIPM(1969)}$. Errors are standard deviations. (auth)

32282 ENHANCEMENT OF SUPERCONDUCTING TRANSITION TEMPERATURES IN MARTENSITIC Ti–Mo ALLOYS. Collings, E. W.; Ho, J. C. (Battelle Memorial Inst., Columbus, Ohio). Phys. Lett., 29A: 306-7(June 2, 1969).

The martensitic structure resulting from the quenching of dilute Ti–Mo alloys is responsible for enhanced values of superconducting transition temperatures, compared to those expected for less-faulted lattices. (auth)

32283 SUPERCONDUCTIVITY IN SYSTEMS WITH ARBITRARY INTERACTION SIGN. Kirzhnits, D. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 9: 213-15(Mar. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 360-4(Mar. 20, 1969).

The usually assumed necessary condition for the occurrence of superconductivity is that the sign of the effective interaction of the quasi particles on the Fermi boundary (FB) be negative. Actually, this condition is valid only for an interaction having a peak on the FB itself. Yet this peak may turn out to be shifted relative to the FB, by a distance exceeding its width. In this case, "pairing" of the quasi particles on the FB is possible only as a result of second-order processes, which lead to an effective attraction regardless of the sign of the interaction, including the case of repulsion forces. The quantitative aspect of this question is clarified here and several physical applications are discussed. (TSS)

32284 SUPERCONDUCTIVITY IN QUANTIZING SEMICONDUCTING FILMS WITH A GRANULATED METALLIC COATING. Pashitskii, E. A.; Tomchuk, P. M. (Inst. of Physics, Kiev). JETP Lett. (USSR) (Engl. Transl.), 9: 218-20(Mar. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 367-71(Mar. 20, 1969).

In connection with the problem of high-temperature superconductivity, a large number of theoretical models have been proposed recently, indicating that in principle it is possible to effect various nonphonon mechanisms of pairing the free carriers (conduction electrons); these models are based on collective Coulomb effects. A characteristic feature of all these models is the assumed presence of an auxiliary subsystem of charges with sufficiently large polarizability (bound electrons in lateral chains of polymer molecules, excitons in dielectrics or in superconducting coatings of "sandwiches," d-electrons in transition metals and alloys, and "heavy" holes in degenerate semiconductors and semimetals). Here, attention is called to one more type of system with high polarizability, namely, granulated metallic films consisting of individual particles (granules) with dimensions ~50 Å, the dispersion properties of which were investigated previously. (TSS)

32285 CRITICAL CURRENTS OF SUPERCONDUCTORS IN LOW FIELDS. Giliani, Noorallah; Britton, R. B. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 40: 949-51(July 1969).

Low field critical currents of unstabilized superconductors such as Nb_3Sn ribbon are usually difficult to obtain for two reasons. First, the current requirements (and associated lead-in losses) become excessive and, secondly, sample burnout may be troublesome unless the power supply is limited to a low open circuit voltage. A technique is described that circumvents both problems by coupling the sample to the power supply with a transformer. (TSS)

32286 ISOTOPE SIEVE FOR ^{4}He vs ^{3}He. THE LOW-TEMPERATURE HEAT CAPACITY OF SiO_2 GLASS BEFORE AND AFTER CONTACT WITH ^{4}He AND ^{3}He. Hornung, E. W.; Fisher, R. A.; Brodale, G. E.; Giauque, W. F. (Univ. of California, Berkeley). J. Chem. Phys., 50: 4878-86(June 1, 1969).

The heat capacity of two samples of annealed SiO_2 glass has been measured over the range 0.5° to 4.2°K. The data for a solid cast cylinder are represented by $C = 0.33T + 0.271T^3 + 0.0220T^5$ μgibbs/g. A hollow cylinder made from tubing gave the result $C = 0.26T + 0.234T^3 + 0.0165T^5$ μgibbs/g. The heat capacity of each sample was also measured at 90 kG with no detectable change. It has been found that ^{4}He can be sorbed by the glass at temperatures below 4.2°K and cannot be appreciably removed by long evacuation at 4.2°K. This effect has been studied in terms of the temporarily altered heat capacity after the glass has been exposed to liquid and gaseous ^{4}He. Similar experiments with ^{3}He indicate that it is not sorbed in SiO_2 glass below 4.2°K, and exposure to liquid or gaseous ^{3}He produces no change in heat capacity. It is suggested that SiO_2 glass may be useful in separating ^{3}He and ^{4}He by selective sorption. (auth)

32287 APPARATUS FOR THE INVESTIGATION OF SUPERCONDUCTIVITY UNDER PRESSURE UP TO 50 kbar. Vereshchagin, L. F.; Il'ina, M. A.; Itskevich, E. S. (Inst. of Physics of High Pressures, Moscow). Prib. Tekh. Eksp., No. 1, 219-21 (Jan.-Feb. 1969). (In Russian).

Apparatus for measurement of electrical resistance under quasi-hydrostatic pressure and at liquid helium temperatures is described. The apparatus consists of two multipliers, one of which is immersed in liquid helium. In order to test the apparatus, measurements of the relation $T_k(p)$ for Tl were made. The phase diagram for Tl at low temperatures was determined. (tr-auth)

32288 ENERGY GAPS IN THE EXCITATION SPECTRUM OF A SUPERCONDUCTOR. van Gelder, A. P. (Katholieke Univ., Nijmegen, Netherlands). Phys. Rev., 181: 787-8(May 10, 1969).

It is shown, for a particular model where the order parameter $\Delta(r)$ is a one-dimensional periodic step function, that the spectrum of the elementary excitations of a superconductor consists of disjunct energy bands, separated by forbidden intervals. (auth)

32289 OBSERVATION OF DECREASE OF SUPERCURRENT IN THE GAPLESS REGION. Hansen, O. P. (Univ. of Copenhagen). Phys. Rev., 181: 671-82(May 10, 1969).

The dependence of superfluid current density J on superfluid velocity v was measured in a hollow superconducting cylinder of indium placed in an axial low-frequency magnetic field. In order to enter the v region for which a decrease of J as a function of v is predicted, the interior of the cylinder was filled with a superconducting rod. The measured quantities were the flux ϕ_J arising from J and the magnitude H_e of the low-frequency magnetic field which is related to v. The experimental results are graphs showing ϕ_J as a function of H_e. At temperatures close to the transition temperature of the film, the $\phi_J - H_e$ graphs were linear for small H_e, whereas for larger H_e, a maximum in ϕ_J followed by a decrease was clearly observed. The temperature dependence and the maximum value of ϕ_J were found—within experimental accuracy—to be in agreement with the predictions of the Ginzburg–Landau theory. (auth)

32290 NERNST EFFECT AND FLUX FLOW IN SUPERCONDUCTORS. I. NIOBIUM. Huebener, R. P. (Kernforschungsanlage, Juelich, Ger. Argonne National Lab., Ill.); Seher, A. Phys. Rev., 181: 701-9(May 10, 1969).

Flux flow induced by a temperature gradient and by an electrical current has been studied in foils of high-purity niobium with a thickness from 11 to 18 μ. From the data, the transport entropy S_ϕ associated with a fluxoid was estimated. For magnetic fields below about 1000 G, the order of magnitude of S_ϕ is similar to that of theoretical estimates for an isolated vortex. The critical temperature gradient was found to decrease with increasing magnetic field. The critical current was larger by 1 to 2 orders of magnitude than the value expected from the critical temperature gradient, assuming that the critical current contributes fully to the Lorentz force on a fluxoid. The experiments suggest that the critical current flows predominantly along the surface of the specimens in such a pattern that there is very little interaction with the flux lines and correspondingly only a small contribution to the Lorentz force. Using Nernst probes at more than one location of the same specimen, details of the flux flow caused by the temperature gradient could be determined. Besides the transverse Nernst voltages, relatively large longitudinal voltages were detected. These longitudinal voltages have opposite sign on both sides of the specimen and are associated with fluxoids entering or leaving the specimen through the sides in transverse direction. (auth)

32291 NERNST EFFECT AND FLUX FLOW IN SUPERCONDUCTORS. II. LEAD FILMS. Huebener, R. P. (Kernforschung-

sanlage, Juelich, Ger. Argonne National Lab., Ill.); Seher, A. Phys. Rev., 181: 710-16(May 10, 1969).

Thermally induced and current-induced flux motions were studied through the Nernst effect and the flux-flow resistivity, respectively, in superconducting lead films. The film thickness ranged between 1 and 7 μ. In addition to the transport entropy of a fluxoid and the flux-flow resistivity, the critical temperature gradient and the critical current, at which thermally induced or current-induced flux motion sets in, were determined. At 375 Oe and 4.2°K, the transport entropy per unit flux S_φ/φ was found to increase with increasing film thickness up to a thickness of about 3 μ. For thicker films, S_φ/φ decreased with increasing film thickness. For a film thickness near 3 μ, S_φ/φ was close to the value expected for a large flux bundle from the difference in entropy density of normal and superconducting material. The critical current density and thereby the critical Lorentz force per unit length of fluxoid were found to increase strongly with decreasing film thickness, whereas the critical thermal force varied little with film thickness. The critical apparent Lorentz force was larger than the critical thermal force by 2 to 3 orders of magnitude, the discrepancy increasing with decreasing film thickness. These results suggest that in a thin film the critical current flow predominantly along the surface in such a pattern that there is very little interaction with the fluxoids in the film. Apparently, at and below the critical current, the electrical current flow in a thin film is such that it contributes only very little to the Lorentz force on the fluxoids. (auth)

32292 INTRINSIC FLUCTUATIONS IN SUPERCONDUCTING RINGS CONTAINING ONE-DIMENSIONAL WEAK LINKS. McCumber, D. E. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 181: 716-28(May 10, 1969).

The Langer–Ambegaokar statistical theory of dissipative fluctuations in narrow superconducting channels is extended to describe the quantum transitions of a closed superconducting ring containing a long one-dimensional weak-link section. The external magnetic flux Φ_e linking the loop is the independent thermodynamic variable. Based upon the Ginzburg–Landau free energy, the theory is expected to accurately describe single-quantum transitions for T near but slightly below T_c. Data reported by Lukens and Goodkind for thin-film Sn rings are reasonably consistent with the theory, but more definitive experimental tests are required. (auth)

32293 SUPERCONDUCTIVITY IN NONTRANSITION METALS. I. Rajput, J. S.; Gupta, Ashok Kumar (Univ. of Allahabad, India). Phys. Rev., 181: 743-52(May 10, 1969).

The theoretical calculation of superconducting-state parameters $\langle V_{ph}\rangle$, $\langle V_C\rangle$, and Z_0 [$\langle V_{ph}\rangle$ estimates the phonon-mediated attractive electron–electron interaction in the metal; $\langle V_C\rangle$, the Coulomb pseudopotential, measures the effectiveness of the Coulomb repulsion in inhibiting superconductivity; and Z_0, the quasiparticle mass (or energy) renormalization parameter, takes into account the many-body renormalization effects due to electron–phonon and Coulomb interactions] is undertaken for both nonsuperconductors and simple-metal (nontransition-metal) superconductors. The two questions faced are: why nonsuperconductors (alkali, alkaline-earth, and noble metals) are nonsuperconductors (this question arises from the startling prediction by Morel and Anderson that all metals should be superconductors); and whether better agreement can be achieved between theoretically estimated superconducting-state parameters and empirical parameters—better, e.g., than those of Pines and of Morel and Anderson. This calculation is differentiated from that of Morel and Anderson first in using electron–phonon and Coulomb-interaction matrix elements between Bloch electron states, secondly in using for the electron–phonon matrix element the form suggested by Harrison for the orthogonalized-plane-wave form factor, and lastly in including the renormalization effects due to electron–phonon and Coulomb interactions. The renormalization due to Coulomb interaction is included by taking the values from the calculations by Rice. The Bloch electron states are calculated in a model in which the ionic core is replaced by a three-dimensional constant repulsive potential, and the wave function is determined in the spirit of the Wigner–Seitz approximation and first-order perturbation theory. The theoretically estimated parameters $\langle V_{ph}\rangle$, $\langle V_C\rangle$, and Z_0 are compared with the empirically estimated parameters. These are also compared with the parameters estimated by Garland. A good comparison—better than that of Morel and Anderson—is found between theoretical and empirical parameters. It is pointed out that if renormalization effects are included in the calculation by Morel and Anderson, then their apparently good comparison with empirical parameters does not remain so good. In the case of nonsuperconductors, it is found that the phonon-mediated attractive interaction fails to dominate over the Coulomb repulsion, contrary to the conclusions of Morel and Anderson, and the effective interaction strength $(\langle V_{ph}\rangle - \langle V_C\rangle)/Z_0$, which is analogous to the BCS parameter N_0V, is repulsive or very slightly attractive. The nonsuperconducting status is thus restored to alkali and alkaline-earth metals. (auth)

32294 FAR-INFRARED STUDY OF SUPERCONDUCTORS CONTAINING MAGNETIC IMPURITIES. Dick, G. J.; Reif, F. (Univ. of California, Berkeley). Phys. Rev., 181: 774-83 (May 10, 1969).

A new far-infrared method has been developed to study the energy-gap properties of a thin superconducting film containing magnetic impurities, and which is thus capable of exhibiting gapless superconductivity. The method allows the direct determination of the real part σ_1 of the conductivity of the superconductor by measuring calorimetrically the infrared radiation absorbed by the film. The systems studied were quenched films of lead containing either Gd or Mn impurities. The experimentally observed frequency dependence of σ_1 (which exhibits the properties of the energy gap) is found to be distinctly different from that expected for nonmagnetic impurities. In the case of lead films containing Gd impurities, whose spins are due to 4f electrons, the behavior of σ_1 is in good quantitative agreement with the behavior predicted by Skalski et al. on the basis of the Abrikosov–Gorkov theory. In the case of lead films containing Mn impurities, whose spins are due to 3d electrons, the behavior of σ_1 is affected more drastically than predicted by this theory. These results agree with conclusions obtained in previous tunneling measurements on these systems. (auth)

32295 TUNNELING, ZERO-BIAS ANOMALIES, AND SMALL SUPERCONDUCTORS. Zeller, H. R.; Giaever, I. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev., 181: 789-99(May 10, 1969).

Tunnel junctions were prepared which contain small Sn particles imbedded in the oxide barrier. The size distribution of the small particles has been determined from electron micrographs. The electrical characteristics of these junctions were measured in the temperature range 1 to 300°K and in magnetic fields up to 100 kOe. All junctions show a large temperature-dependent resistance peak at zero bias and at low temperatures. The resistance peak increases in magnitude when the Sn particles are made superconducting. A simple model based upon the capacitance of the particles can account quantitatively for this behavior. It is believed that a simple extension of this model can account for at least some of the previously reported zero-bias resistance anomalies. From the experiment, it is also possible to extract information about the superconductivity of small particles. It is found that Sn particles down to at least a radius $r \sim 25$ Å are superconducting. The transition temperature of the particles increases with decreasing particle size and reaches 4.2°K for particles with $r \sim 70$ Å, compared with $T_c = 3.7$°K for bulk Sn. In the radius range $r > 100$ Å, the critical field of the particles can be described in terms of a theory by De Gennes and Tinkham. Smaller particles have a much higher critical field, which increases more rapidly with decreasing radius than predicted by that theory. (auth)

32296 FLUCTUATION ROUNDING OF THE RESISTIVE SUPERCONDUCTING TRANISTION IN THIN LEAD FILMS. Testardi, L. R.; Reed, W. A.; Hohenberg, P. C.; Haemmerle, W. H.; Brennert, G. F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev., 181: 800-11(May 10, 1969).

The effect of fluctuations on the resistive transition to superconductivity has been studied in thin (100 to 200 Å) Pb films. Although the temperature dependence of the fluctuation contribution is given by $(T-T_c)^{-1}$, and the width of the transition increases with increasing film resistance as predicted by Aslamazov and Larkin, this width is found to be smaller than the theoretical value by factors of 2 to 14. The transition from two- to three-dimensional behavior, expected theoretically in one of the samples studied, was not observed. A similar failure is found on analyzing published data for Al and (possibly for) amorphous Bi films. The various approximations used to derive the theory, and their effect on the analysis of the data (which has been carried out with no fitted parameters), are discussed in detail. The quantitative applicability of the Aslamazov–Larkin theory is considered in the light of its discrepancies with experiment. However, no explanation is found consistent with all published data. For one sample, measurements were performed in a magnetic field; a discussion of additional broadening mechanisms in a magnetic field is presented. (auth)

32297 CRITICAL CURRENT OF THIN FILMS FOR DIFFUSE REFLECTION FROM THE WALLS. Ovchinnikov, Yu. N. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1590-1607(May 1969). (In Russian).

Boundary conditions for the Green function are obtained for diffuse reflection of electrons by the sample boundaries. The critical current and excitation spectrum of thin films with a current are found and the excitation spectrum in strong magnetic

fields is determined. The dependence of the penetration depth on field strength is considered. (auth)

32298 OSCILLATION SPECTRUM OF VORTEX FILAMENTS. Baramidze, G. A. (Inst. of Physics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz., 56: 1755-62(May 1969). (In Russian).

The oscillation spectrum of isolated vortex filaments is studied for two microscopic models: (1) for the model of a charged Bose gas, and (2) for charged superconductors with paramagnetic atom impurities. It is shown that in case (1) there exist three branches of the function $\omega(k)$, two of which possess a gap; the third, gapless branch is related to conductivity due to normal electrons. In case (2) the frequency possesses only an imaginary part which corresponds only to damping of the oscillations. The results indicate that the hydrodynamic treatment is invalid. (auth)

32299 ON SOME PROPERTIES OF LAMELLAR STRUCTURES. Kats, E. I. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1675-84(May 1969). (In Russian).

Fluctuations of the electron density and ordering parameter phase, the magnetic properties, and properties of the superconducting transition in lamellar structures are investigated. The dependence of the critical field on direction is derived which is characteristic for such systems. The calculations are carried out in the logarithmic approximation. (auth)

32300 ON THE "SUPERHEATED" STATE OF SUPERCONDUCTORS OF THE FIRST KIND. Shikin, V. B. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 56: 1685-92(May 1969). (In Russian).

A method is proposed for observing some superheated states of superconductors of the first kind which ordinarily are in the instability region. (auth)

32301 LARGE SHIFTS OF TRANSITION TEMPERATURE WITH ELECTRIC CHARGING PREDICTED FOR "SUPERCONDUCTING SEMICONDUCTORS". Berlincourt, T. G. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Lett., 29A: 308-9(June 2, 1969).

"Superconducting semiconductors" should exhibit much larger electric charging induced shifts of T_c than occur in ordinary metals. Data on these shifts would enable critical tests of superconductivity theory for such materials. The large anticipated shifts make electric switching devices feasible. (auth)

32302 NONLINEAR PRESSURE EFFECT ON THE ELECTRONIC DENSITY OF STATES OF INDIUM. Dummer, G. (Univ. of Illinois, Urbana). Phys. Lett., 29A: 311-12(June 2, 1969).

The pressure dependence of γ of In was determined directly from low-temperature measurements of the changes of the critical field under pressure. The observed change of H_c under hydrostatic pressure does not follow the predictions of the similarity principle. (auth)

32303 INDUCTIVE BEHAVIOR OF RESISTIVE SUPERCONDUCTORS. Wyatt, A. F. G. (Univ. of Nottingham, Eng.). Phys. Lett., 29A: 353-4(June 2, 1969).

A resistive superconducting microstrip behaves as an inductance and this leads to finite times for current fluctuations and the possibility of a resonant circuit. (auth)

32304 POSSIBLE EFFECT OF PARAMAGNETIC CENTERS ON THE SUPERCONDUCTING TRANSITION IN OXYGEN-DEFICIENT $SrTiO_3$. Phillips, N. E. (Univ. of California, Berkeley); Ho, J. C.; Woody, D. P.; Hulm, J. K.; Jones, C. K. Phys. Lett., 29A: 356-7(June 2, 1969).

It is suggested that paramagnetic centers, identified by their contribution to the low-temperature heat capacity, are important in determining the apparent dependence of T_c on carrier density in reduced $SrTiO_3$. (auth)

32305 PHASE TRANSITION IN THE PAIR-HAMILTONIAN MODEL FOR LIQUID HELIUM. Reatto, L. (Univ., Milan); Straley, J. P. Phys. Rev., 183: 321-7(July 5, 1969).

The thermodynamic properties of two models for degenerate Bose liquids have been investigated. The models are found to give a first-order phase transition. This aspect of the models is related to the collapse of the long-wavelength excitation spectrum as the condensate density vanishes. (auth)

Plasma and Thermonuclear Physics

32306 (STI/PUB-192(Vol.1)) PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH. VOL. I. Proceedings Series. Proceedings of the Third International Conference, Novosibirsk, 1-7 August 1968. (International Atomic Energy Agency, Vienna (Austria)). 1969. 1010p. (CONF-680805-(Vol.1)). IAEA $23.00; Austrian Schillings 595, (In several languages); £ 9.11.8; F.Fr. 112,70; DM 92,-.

Separate abstracts were prepared for the 64 papers of this volume. The Russian papers appearing in this volume have been translated into English and appear in the journal Nuclear Fusion (Special Supplement, 1969). (M.O.W.)

For abstracts of individual papers see: 32311, 32329-32342, 32355, 32364-32366, 32389-32399, 32426, 32427, 32436-32438, 32440, 32448-32451, 32474-32480, 32492-32494, 32499-32501, 32512, 32513, and 32519-32527.

32307 (STI/PUB-192(Vol.2)) PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH. VOL. II. Proceedings Series. Proceedings of the Third International Conference, Novosibirsk, 1-7 August 1968. (International Atomic Energy Agency, Vienna (Austria)). 1969. 849p. (CONF-680805-(Vol.2)). IAEA $19.50; Austrian Schillings 504, (In several languages); £8.2.6; F.Fr. 95,60; DM 78,-.

Separate abstracts were prepared for the 61 papers of this volume. The Russian papers appearing in this volume have been translated into English and appear in the journal Nuclear Fusion (Special Supplement, 1969). (M.O.W.)

For abstracts of individual papers see: 32312-32328, 32361-32363, 32376-32383, 32386-32388, 32424, 32425, 32439, 32452-32473, 32496-32498, 32517, and 32518.

Confinement and Heating

Refer also to abstracts 32207, 32438, 32461, and 32465.

32308 (NP-tr-1775) EXPERIMENTAL INVESTIGATION OF THE EFFICIENCY OF RAPID PLASMA HEATING METHODS. Dubovoi, L. V.; Fedyakov, V. P. (Leningrad Electrical Engineering Inst. (USSR)). Translated for Culham Lab., Abingdon, Eng., from a Russian reprint. 10p. (CTO-520). Dep. CFSTI.

The generation and absorption in a plasma of an ion cyclotron wave in which the peak value of the variable magnetic field components H_z in the region of the exciting circuit varied from 0.05 to 0.6 of the stationary confining field $H_z = 2.13$ kG were investigated. The time for generating a wave packet was $\delta t \approx 10^{-6}$ sec and, under the experimental conditions, always satisfied the relation $\delta t < \tau$. (M.O.W.)

32309 SCALING OF TOROIDAL PLASMA CONFINEMENT TIMES. Meade, D. M.; Molvik, A. W.; Rudmin, J. W.; Schmidt, J. A. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 22: 1354-7(June 23, 1969).

An alternative scaling law with which to judge toroidal confinement experiments is discussed. A phenomenological model of $(\vec{E} \times \vec{B})$-driven convective cells of diameter comparable with the minor diameter of the plasma is used to derive a new scaling law for plasma containment time. Using new experimental results it is shown that this law describes a large number of toroidal experiments better than does earlier interpretation in terms of "Bohm" diffusion. (auth)

32310 HEATING OF ELECTRONS IN A WEAKLY IONIZED PLASMA BY HIGH-FREQUENCY ELECTROMAGNETIC WAVES. Singh, R. N.; Singh, R. P. (Banaras Hindu Univ., India). J. Phys., A (London), 2: 330-3(May 1969).

The plasma perturbation in the presence of a high-frequency electromagnetic field is represented by a Maxwellian distribution function. The electron energy gained in the plasma in the presence of the applied electromagnetic field is calculated from the Boltzmann transport equation. The variation of electron energy with the duration of the field is also calculated. It is shown that the electromagnetic field interaction with an extended plasma results in a steady-state electron temperature. The time for the electron temperature to reach the steady state is found to depend on the electron collision frequency. (auth) (UK)

32311 LOW-FREQUENCY PLASMA LOSS MECHANISMS IN MHD-STABILIZED TORUSES. Furth, H. P.; Rosenbluth, M. N. (Princeton Univ., N. J.). pp 821-45 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Anomalous plasma losses can occur even in the absence of apparent fluctuations, through the mechanism of large single-particle excursions in spatially irregular quasi-static magnetic and electric fields. The conservation of the second adiabatic invariant J provides the basis for a general analysis of these

low-frequency mechanisms. In sheared magnetic fields, the presence of a regular electrostatic potential $e\Phi_0 > kT r_0/R_0$, constant on magnetic surfaces, is sufficient to suppress single-particle excursions in both axisymmetric and stellarator geometry. The effect on particle excursions of irregular electrostatic potentials is investigated and in the limit of small gyroradii and strong shear is found to be comparable to the effect of nonsymmetric (stellarator) geometry. Magnetic trapping of particles lends itself to self-consistent irregular potentials (convective cells), while electrostatic trapping leads to a stable drift mode, and to the possibility of convective cells. Shearless magnetic wells (multipoles), are unstable against growth of MHD convective cells. For small plasma potentials, however, the instability goes to short wavelength where the MHD approximation breaks down. Small gyroradii and deep magnetic wells are found to be favorable to the suppression of particle convection. (auth)

32312 TURBULENT HEATING OF PLASMA BY MEANS OF A CURRENT. Zavoiskii, E. K.; Nedoseev, S. L.; Rudakov, L. I.; (and others) (Inst. of Atomic Energy, Moscow). pp 679-91 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Results are presented of turbulent plasma heating experiments in mirror and closed magnetic traps under widely varying experimental conditions. The plasma heating effect is explained by the collective interactions that occur when the electron current velocity exceeds a certain critical value. A high noise level is then observed in the plasma, the resistance of the plasma becomes abnormally high, and the energy of the external current source is imparted to the plasma electrons and ions with an efficiency much greater than that achieved with energy dissipation methods governed by pair collisions. In the magnetic-mirror-trap experiments, the plasma density varied between 10^{12} and 4×10^{13} cm^{-3} and the quasi-stationary magnetic field from 1 to 25 kOe. The efficiency of turbulent heating, the heating energy balance, and particle and energy losses both along and across the magnetic field were studied. It was shown that increases in the longitudinal electric field producing the current in the plasma are accompanied by increases in the strength of the quasi-stationary magnetic field, ensuring minimum plasma energy and particle losses during the passage of the heating current. The dependence of the efficiency of turbulent heating on the strength both of a quasi-stationary magnetic field and of a high-frequency longitudinal electric field was studied in toroidal magnetic traps. Using noncontact diagnostic methods (investigation of the epithermal radiation of the plasma in the region of the electron plasma frequency, noncoherent scattering in the plasma of uhf electromagnetic waves, etc.), the oscillation spectrum of the turbulent plasma was analyzed. Plasma containment after turbulent heating was studied in a toroidal trap with a strongly corrugated magnetic field; the plasma density was 10^{12} to 10^{13} cm^{-3} and the pressure of the turbulently heated plasma $nT \sim 10^{15}$ to 10^{16} eV cm^{-3}. (auth)

32313 EXPERIMENTAL STRONG TURBULENT HEATING. Neidigh, R. V.; Alexeff, I.; Guest, G. E.; Jones, W. D.; Montgomery, D. C.; Rose, D. J.; Stirling, W. L. (Oak Ridge National Lab., Tenn.). pp 693-708 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Experiments at ORNL are exploring the strong turbulent interaction between a steady-state, magnetically collimated electron beam and its self-generated plasma. The technology to maximize ion heating is being developed in Burnout V, a simple mirror device with magnetic fields of 50-25-50 kG, and with an axial electron beam (6 A at 10 kV) that gives a beam power density in the plasma exceeding one kW cm^{-3}. Necessary, but not sufficient, evidence for a true thermonuclear temperature is the observed 10^3 s^{-1} cm^{-3} plasma source of 3-MeV protons identifying D-D reactions. Spectral measurements of recombination radiation reveal a line width corresponding to an ion energy of 0.5 keV. Analysis of charge-exchanged neutral atoms reveals the energy spectrum in more detail with a maximum between 100 and 500 eV and as much as 10% near 1 keV. A flux of 3×10^{14} cm^{-2} s^{-1} of 100-keV deuterons escapes the midplane perimeter. Calorimetric probes measure a plasma heating effect equivalent to 0.5-keV ion bombardment at 2.5×10^{12} cm^{-3}. The rate of decrease of spectral radiation toward the plasma center establishes an electron density of at least 2.5×10^{12} cm^{-3}. The confinement time, 2×10^{-4} s estimated from density and energy balance, agrees well with the measured spectral-light decay time and is equivalent to hundreds of ion transits through the plasma. Ion heating was observed to increase strongly with increasing magnetic field strength, suggesting a direction for future development. In previous experiments, electrons were heated to temperatures exceeding 100 keV with densities greater than 10^{11} cm^{-3}. To study these oscillations, special impedance-matched probes now have been used to measure plasma electron oscillation frequencies up to 4 kMc, coherence times, and electric field values with the aid of traveling-wave-tube oscilloscopes. Simple methods related to correlation techniques have been used to estimate the auto- and cross correlations on the signals observed on two electrostatic probes, with the aid of sampling oscilloscopes used as high-speed gates. These techniques allow observation of "average" frequencies up to 2 kMc and "average" wavelengths observed to be a few cm. All these new techniques aid in determining the dispersion relation and other important quantities for the plasma electron oscillations, and help in determining the direction for future progress. (auth)

32314 INVESTIGATION OF THE MECHANISM OF BEAM HEATING OF A PLASMA IN A MAGNETIC MIRROR TRAP. Plakhov, A. G.; Ryutov, D. D.; Shapkin, V. V. (Inst. of Atomic Energy, Moscow). pp 709-22 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The heating of electrons by a powerful electron beam passing through a cold plasma was investigated. The experimental facility consists of a magnetic mirror machine with a large mirror ratio. The maximum magnetic field is 2 kOe at the middle of the trap and 10.5 kOe in the mirrors. The pulsed electron beam, with a current of up to 20 A and an accelerating voltage of up to 35 kV, is injected along the magnetic field into the trap, which contains a previously prepared cold plasma. The trap is filled with this cold hydrogen plasma by means of a titanium injector. The initial plasma concentration is (1 to 2) $\times 10^{12}$ cm^{-3} and the temperature 5 to 10 eV. During the passage of the electron beam the total plasma concentration remains virtually unchanged, but the electron distribution function changes substantially. The plasma breaks down into two components that differ considerably in density and temperature. The hot electron concentration reaches a value of 10^{10} cm^{-3}. The mean energy of these electrons (as high as 200 keV) significantly exceeds the energy of the beam particles. The electron energy depends on the duration of the electron pulse, the strength of the magnetic field, and the transverse dimensions of the plasma. The containment time for the hot plasma is limited by collisions with the neutral gas. The plasma is observed to emit x-rays over a period of 5 to 10 s. The hot plasma expands rapidly across the magnetic field and achieves dimensions exceeding the transverse dimensions of the beam by a factor of more than 20. The expansion rate depends on the magnetic field and the beam parameters. Expansion of the plasma is accompanied by an increase in electron energy, while the mean energy density of the hot plasma remains constant even when the plasma volume changes by a factor of more than 10. In the small region occupied by the beam, the energy density of the hot plasma exceeds the overall mean density by a factor of about two. A beam heating model based on the assumption that the source of accelerated particles is an electron beam is proposed. The experimental results are in satisfactory agreement with this model. (auth)

32315 GENERATION AND HEATING OF PLASMA BY BEAM-PLASMA INTERACTION. Jancarik, J.; Kopecky, V.; Piffl, V.; Pohanka, J.; Preinhaelter, J.; Seidl, M.; Sunka, P.; Ullschmied, J. (Inst. of Plasma Physics, Prague). pp 733-47 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The excitation of high-frequency fields in beam-plasma systems, their absorption in the plasma, and their effect on the plasma parameters were investigated both theoretically and experimentally. The experiments were performed in a homogeneous as well as in a mirror-type magnetic field, and with various electron beams. In a homogeneous magnetic field the frequency and wavelength of the excited waves are in good agreement with the linear theory, nonlinear effects causing relaxation in space and time. Strong absorption of the excited waves is due to the radial inhomogeneity of the plasma, and it occurs near cyclotron harmonics. Using these facts, the successive stages of plasma buildup from neutral gas were clarified and the conditions for breakdown

established. In a mirror-type magnetic field the spectrum of the instabilities is the same as in a uniform field, but the oscillations are localized in regions where the inhomogeneity is small. Effective heating of electrons occurs if the excited waves are absorbed in the containment region and the particles gain perpendicular energy. Strong absorption of the waves occurs again as a result of inhomogeneities. In addition to the radial density inhomogeneity, the absorption is also affected by the longitudinal inhomogeneity of both the magnetic field and plasma density. The waves excited in the containment region are absorbed by the warm plasma electrons in regions where the resonance condition $\omega = \tilde{n}\omega_{ce}$ can be reached. The waves excited in the mirrors can be absorbed by the inhomogeneities of either the magnetic field or the plasma density. The limitations of beam–plasma interactions for plasma heating are discussed. (auth)

32316 CONFINEMENT OF COLLISION-DOMINATED PLASMA AND PRODUCTION OF HOT ELECTRON PLASMA IN A MIRROR θ-PINCH. Sato, Ka.; Sato, Ko.; Shiina, S.; Murata, H.; Ohnishi, H.; Sato, M.; Kawakami, I.; Yokoyama, K.; Yoshimura, H. (Nihon Univ., Tokyo). pp 657-65 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The relation of the confinement and axial motion of the collision-dominated plasma produced in a mirror θ pinch is investigated. Without a reverse trapped field, it is found that clear luminous fronts propagate from the mirror parts to the control part after the radial compression and are reflected back to the mirror parts. This axial behavior is observed only in mirror configuration and never in straight configuration. The time behavior of the plasma density is characterized by the plasma flow accompanying the propagating luminous fronts. After the axial contraction, the plasma decreases rapidly with time at the midplane and increases at the mirror plane by the reflected plasma flow. From numerical computation, one can find remarkable agreement between theory and experiment. Thus it is concluded that the confinement time of the plasma produced in the mirror θ pinch is mainly determined by dynamic behavior accompanying the density bore that propagates along the plasma column. At low initial pressures, hard x rays with maximum energy of more than 300 keV were observed in the mirror θ pinch. It was found from the measurements by collimated scintillation detectors that the observed hard x rays are bremsstrahlung from hot electron plasma trapped in the mirror field. The plasma produced is composed of four components: hot electrons, cold electrons, cold ions, and neutral gas. The confinement time of the trapped plasma with densities $\sim 10^{13}$/cm is about 200 μs in a mirror field with the mirror field with the mirror ratio 1.5, and this confinement time is one order longer than that of a simple cold plasma without hot electrons. To clarify the acceleration mechanisms, the energy spectra of hard x rays emitted from the hot electron plasma were measured under various conditions. The results show that the existence of the high-energy electrons cannot be explained by the acceleration of a single particle in the rising magnetic field. It was also found that the betatron mechanism cannot be operating in the conditions of the experiment. (auth)

32317 THETA-CUSP CONTAINMENT. Spalding, I. J.; Eden, M. J.; Phelps, A. D. R.; Allen, T. K. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 639-49 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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Previous measurements of cusp containment were made under conditions where the end losses may be explained either as a direct consequence of anomalous diffusion occurring at the plasma boundary, or by finite gyroradius effects caused by wall short-circuiting of space-charge electric fields. A new cusp-ended θ-pinch experiment was therefore designed in which the calculated $\beta = 1$ collision-free losses through an ion gyroradius sheath are much slower than the end losses to be expected if diffusion occurs at the Bohm rate across the high-β boundary. This experiment (CENTAUR) also permits a direct comparison of the gross stability of the MHD stable cusp geometry with that of a simple θ pinch. The θ-pinch plasma has a diameter of more than 20 ion collision-free skin depths, and measured values of T_e, n_e, and β on the axis are in fair agreement with the Hain–Roberts (MHD) code at times near maximum compression ($t = 2$ μs), being typically 150 eV, 1.5×10^{16} cm^{-3}, and 99 ± 1%, respectively. The ratio of the Bohm-to-classical-diffusion coefficients is about 70. The radially averaged $\bar{\beta}$ is 83 (±5% and, at this value of $\bar{\beta}$, the simple θ pinch is stable to the m = 1 mode for at least 6 sound-transit times, as suggested by a recent MHD theory. The gross stability in θ-cusp geometry is described in some detail. The containment observed in both θ and θ-cusp geometries excludes wall short-circuiting effects as the sole cause of plasma loss. Either β is lowered by a few percent throughout the plasma volume during the initial formation of the plasma, or diffusion occurs at roughly the Bohm rate throughout the equilibrium phase of the discharge (2 to 15 μs). The apparent broadness of the sheath, and fluctuations observed near the ion-cyclotron frequency appears to support the latter explanation, which implies a different scaling of containment time with length. Finally, some recent calculations of the probable geometry and dimensions of any open-ended $\beta = 1$ reactor are summarized. Such reactors must be pulsed, and if the plasma is completely quiescent, are roughly 1 km in length, having an output of about 10 GW(E). (auth)

32318 CONFINEMENT OF HIGH-β PLASMA WITH SHEAR IN A HARD-CORE THETA-PINCH. Kolb, A. C.; Dixon, R. H.; Duechs, D.; Elton, R. C.; Young, M. P. (Naval Research Lab., Washington, D. C.). pp 567-80 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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Confinement of high-β plasma in a theta pinch with closed field lines (trapped reverse field) has so far been limited by hydromagnetic instabilities, e.g., rotating flutes appear in Pharos after ~20 μs in a large-bore (17 cm) tube and at earlier times in a small-bore (8.4 cm) tube. To achieve toroidal equilibrium of a high-β plasma in a hydromagnetically stable configuration, it was suggested by Yoshikawa and Kolb that a θ-pinch with a hard, current-carrying core has attractive features. The magnetic topology is identical to Tokomak, and the Kruskal–Shafranov criteria in a hard-core θ-pinch with plasma length L greater than the radius R_D of the plasma annulus becomes $B_z/B_\theta < L/2\pi R_p$. This relation appears to be satisfied in the present experiments so that long-wavelength kink instabilities associated with the toroidal geometry are not expected to be serious. From this historical Tokomak point of view, it is possible to achieve large values of B_z/B_θ in a hard-core θ-pinch which corresponds to a Tokomak with a minor radius larger than the major radius. Because of this feature, the ohmic-heating currents can be relatively large, with corresponding higher densities. The equilibrium for arbitrary β is calculated numerically and found to be in close agreement with experimental results from streak camera photographs and probe data. The instabilities observed so far do not seem to be associated with the toroidal features of the magnetic topology. While the ends (where the curvature is large) may be unstable, there is no evidence that the loss of radial confinement is due to instabilities that propagate from the ends toward the midplane. The connection times are rather long and stabilization due to toroidal effects is not sufficient to suppress rotating flutes in the outer sheath where the Suydam criterion is violated. These flutes are apparently associated with derivations from axial symmetry, perhaps due to slight misalignment of the hard core. (auth)

32319 LIMITATION OF THE CONFINEMENT OF PLASMA IN A LINEAR THETA-PINCH WITH TRAPPED REVERSE MAGNETIC FIELD. Kaleck, A.; Koenen, L.; Noll, P.; Sugita, K.; Waelbroeck, F.; Watanabe, K.; Witulski, H. (Kernforschungsanlage, Juelich, Ger.). pp 581-94 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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At the 128-cm-long theta-pinch experiment (Julietta) the evolution of closed-field configurations produced by compressing plasmas with reverse-bias field was studied, using simultaneously continuum radiation profiles observed at 8 axial positions, the signals of 16 compensated loops, and other diagnostic methods. In a 10.7-cm-diameter coil with full condenser bank (1.2 MJ at 20 kV), the magnetic field rises to $B_{max} = 125$ kG in 12 μs; the decay time after crowbar is 220 μs. The plasma evolution depends strongly on the initial conditions. Using 50-mtorr D_2, a 2-kG reverse-bias field, and part of the condenser bank ($B_{max} = 48$ kG), the electron temperature rises from 5 eV initially to 300 eV at peak compression, and the bulk of the plasma contracts to 1/3 of the coil length. Sharp axial plasma boundaries and a dip in the radial density distribution indicate the existence of closed magnetic field lines. The particle containment time (12 μs) is much shorter than is expected from resistive diffusion and hardly larger than that (8 μs) measured without bias fields. Shortly after the implosion phase, instabilities develop at various

axial positions. They constrict the plasma column radially and split it axially into fragments which often later join again. The resulting annihilation of reverse flux causes probably the fast decay of the plasma and of the average displaced flux. Increasing B_{max} enhances the unstable character of the discharge. The observed growth rates will be discussed in terms of possible tearing-mode instability mechanisms. With 1 kG reverse-bias field, the axial contraction is slower; no large-amplitude constriction is detected. At first (but only during 10 μs) the particle containment time is long (40 to 60 μs). Later, rotational flute instabilities set in; as suggested by Kolb, they cause probably the rapid plasma decay that occurs thereafter. In view of these instabilities, a new small-scale experiment is being built. A helically wound hard core is inserted in a normal coil to produce a high-β compact toroidal plasma. The helical winding produces an inverse theta-pinch field and should allow starting from magnetic-field-free initial plasmas. (auth)

32320 MONTE CARLO AND COMPUTER PLASMA SIMULATION STUDIES OF THE INHIBITION OF END LOSS FROM A θ-PINCH BY NON-ADIABATIC ROUGH MAGNETIC WALLS. Tuck, J. L. (Los Alamos Scientific Lab., N. Mex.). pp 595-605 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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Results are presented of a Monte Carlo computation of 500 particles released at points randomly distributed over the radius into a cylindrical tube with sinusoidally corrugated specularly reflecting walls. Furthermore, a computer-simulated θ pinch plasma is studied; the motion of 13,000 particles in a rectangular net of 2000 cells is observed, and the particle losses under various conditions are reported. (auth)

32321 TOROIDAL HIGH-β EQUILIBRIA. Blank, A. A.; Grad, H.; Weitzner, H. (New York Univ., N. Y.). pp 607-17 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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To contain a toroidal high-β plasma (e.g., the proposed Scyllac device) requires rather complex fields. In the MHD (scalar pressure) and guiding-center theories it has been found that under many circumstances static equilibrium solutions do not exist. This difficulty is not resolved with finite resistivity. It is possible that finite Larmor radius could yield solutions, but for the complex geometries necessary, such a theory does not appear to be feasible. In the past, high-β equilibria have usually been calculated from the $\beta = 1$ plasma model with field excluded from the plasma at a sharp boundary. But all such equilibria are automatically unstable (dynamic stabilization has been suggested to remedy this). The problem of nonexistence of equilibrium solutions does not arise in this model. The same is true of any model with piece-wise constant-pressure layers or piece-wise constant distributions $f(\epsilon,\mu)$. Under certain circumstances the plasma fluctuations which would arise from the lack of equilibrium with a continuous pressure profile can be estimated to be small. In such cases the mathematically expedient step-function equilibrium could be expected to give a fairly accurate representation of the plasma both with regard to equilibrium and stability. The mathematical problem is that of a number of free boundaries separating vacuum field regions (scalar pressure) or $f(\epsilon,\mu)$ regions (satisfying elliptic equations similar to the vacuum field). An equilibrium was obtained in scalar-pressure MHD for arbitrary β as an expansion for a torus of large aspect ratio with a simple helical winding. This equilibrium exists under a wide range of parametric values. There are many different indications of MHD stability of the device and none to the contrary. (auth)

32322 ELECTRON CYCLOTRON HEATED "TARGET" PLASMA EXPERIMENTS. Dandl, R. A.; Dunlap, J. L.; Eason, H. O.; Edmonds, P. H.; England, A. C.; Herrmann, W. J.; Lazar, N. H. (Oak Ridge National Lab., Tenn.). pp 435-48 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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The advantages of trapping an injected, energetic atom beam by charge exchange with ions in a high-density, low-temperature plasma have been discussed previously. Large trapping efficiencies are possible ($\gtrsim$10%) which can lead to high-energetic ion densities ($\sim 10^{12}$ cm^{-3}) even with relatively high loss rates. If, in addition, the "target" plasma were to contain energetic electrons, stability against virtually all ion gyrofrequency instabilities is predicted if the plasma is not too long. The resonant electron-cyclotron heated (ECH) plasmas produced in the past in simple mirror geometry satisfy all the required characteristics except that the ambient pressure required to sustain the cold plasma necessary for MHD stability is unacceptably high ($\sim 10^{-5}$ torr). A quadrupole magnetic well with a ratio of 1.5:1 was introduced into the Interem facility to ensure stability against the low-frequency instabilities in the "target" plasma. This well permits the creation of a dense hot-electron plasma at lower ambient pressures. Experiments carried out in simple mirror configurations were completed. With injected 20-keV beam intensities of $\approx$50 mA H^0 into a "target" density of 4×10^{11} cm^{-3}, the trapped ion density was 5.3×10^{9} cm^{-3} ($\omega_{pi}/\omega_{ci} = 1.1$) and no evidence of instability could be found. A possibility exists for the production of a magnetic well by the self-field of a high-β electron plasma. Experiments in the ELMO facility demonstrated the stable existence of such a high-β configuration produced by ECH. The vacuum magnetic field is a variable-ratio simple-mirror geometry, resonant for the 2-kW, 35-GHz applied heating power. The observed stability is presently attributed to line tying by the cold plasma resulting from the relatively high ambient operating pressure ($\sim 10^{-5}$ torr). Magnetic field mapping indicates that the bulk of the stored energy of the plasma, 4×10^{17} eV/cm^3, lies in an annular belt of relativistic electrons whose temperature lies between limits of 0.5 MeV, set by relaxation time, and 2 MeV, set by neutron yield from the deuteron photodisintegration reaction. Computer calculations simulating the plasma distribution yield a best fit of β of 40 to 60%, corresponding to a magnetic field depression of several kilogauss. (auth)

32323 USE OF HIGH-FREQUENCY FIELDS FOR PLASMA HEATING. Alikaev, V. V.; Arsen'ev, Yu. I.; Bogachev, V. M.; (and others) (Inst. of Atomic Energy, Moscow). pp 381-97 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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The possibilities of heating the electron and ion components of a plasma by means of uhf fields are investigated. In a low-density plasma under conditions of electron-cyclotron heating, the Langmuir frequency is near to the electron Larmor frequency. Heating is carried out in an evacuated cylindrical resonator in which a steady-state magnetic field of the adiabatic-trap type has been produced. Use is made of a generator with a wavelength of the order of 10 cm. The density of the hot electron component reaches a value of $n_e \sim 3 \times 10^{10}$ cm^{-3} at a temperature T_e = 20 to 30 keV. Under certain conditions, plasma afterglow instabilities associated with anisotropy in the electron velocity distribution function were observed. Experiments involving the heating of the electron component of a plasma at the fundamental parametric resonance (uhf generator frequency double the electron Larmor frequency) were carried out in an evacuated cylindrical resonator at a wavelength $\sim$10 cm. It is experimentally demonstrated that it is possible to heat a plasma when the electron Langmuir frequency exceeds the generator frequency by a factor of more than 10. A plasma is obtained with a pressure attaining 20% of the static magnetic field pressure and exceeding the high-frequency field pressure by a factor of almost 10. The possibility of collisionless heating of the ion component of a plasma near the electron–ion hybrid resonance due to Cherenkov absorption of the wave energy was also investigated. For introducing energy into the plasma, a resonator operating at a frequency of 90 Mc and powered by a 30-kW hf generator was developed. In order to obtain the plasma itself, a hf injector was also developed. (auth)

32324 STUDY OF ULTRAHIGH-FREQUENCY PLASMA HEATING IN A MAGNETIC FIELD. Anisimov, A. I.; Budnikov, V. N.; Vinogradov, N. I.; (and others) (Inst. of Physics and Tech., Leningrad). pp 399-413 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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Experiments are described on shaping and heating a plasma in a magnetic field by means of ultrahigh-frequency waves in the 3-cm. range. A broad-band waveguide method was used to supply power to the plasma. With an applied power of 10^{-2} to 100 W/cm^3 (per unit of plasma volume) and hydrogen pressures of 10^{-5} to 10^{-2} mm Hg, a plasma with charged particle densities of 10^{8} to 10^{14} cm^{-3} and electron temperatures of up to 100 eV was produced. The magnetic field region within which it is possible to

introduce ultrahigh-frequency energy into the plasma is determined. At low charged-particle densities, this region is near the cyclotron magnetic field. As the density approaches the critical value, the region expands to take in low magnetic fields in which the maximum value of the upper hybrid frequency is close to the wave frequency. At maximum densities exceeding the critical value, the region in which the plasma is under the influence of the uhf power extends to very low magnetic fields. At such densities it is also possible to achieve absorption in a magnetic field substantially higher than the cyclotron magnetic field. The absorption efficiency in the range of conditions studied is 50 to 90%. Comparison of the experimental data with the results of theoretical analysis indicates that the detected absorption of uhf waves for a wide range of conditions may be associated with a linear wave transformation mechanism. This mechanism may also permit the efficient introduction of energy into a plasma in other frequency ranges as well. (auth)

32325 PLASMA HEATING FROM NON-LINEAR EFFECTS OF LARGE-AMPLITUDE ALFVEN WAVES. Watson-Munro, C. N.; Cross, R. C.; James, B. W. (Univ. of Sydney). pp 195-208 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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In a cylindrical, highly ionized hydrogenous laboratory plasma source, investigations were made of the propagation of Alfvén torsional waves of azimuthal wave field b_θ propagating parallel to a steady magnetic field B_0 in the z direction. The situation was examined up to perturbation ratios b_θ/B_0 of 7.4 and Alfvén Mach Numbers M_A up to 3. It was found that up to a perturbation ratio of about 1.3, theoretical predictions from MHD shock wave theory of shock velocity, density, and temperature behind the shock are experimentally realized. Above this perturbation ratio, theory and experiment depart; marked attenuation of the Alfvén wave occurs and large-amplitude oscillations develop. (auth)

32326 PLASMA CONTAINMENT EXPERIMENTS IN THE PR-6 DEVICE. Baiborodov, Yu. T.; Gott, Yu. V.; Ioffe, M. S.; Sobolev, R. I. (Inst. of Atomic Energy, Moscow). pp 213-24 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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The PR-6 device is an adiabatic trap with minimum B. In its dimensions and magnetic field configuration it is similar to the PR-5, but has a higher field strength. The purpose of the PR-6 experiments was to verify the assumption that the rapid initial decline in density was due to drift-cone instability. Since the critical density for drift-cone instability is proportional to $^{3.5}H$, it was logical to expect a very rapid increase in plasma density with increasing H, if the density was in fact limited by drift-coné instability. In the experiments described, the plasma was produced by injection from an unstable plasma beam. By this method it was possible to fill a trap with a plasma having an initial density $n_0 \approx 10^{11}$ cm^{-3} with $E_i \sim 1$ keV and $T_e \approx 50$ eV. The plasma density was recorded by measuring the attenuation of the beam of thermal potassium atoms. The dependence of density on H_0 was measured for $\alpha_{||} = 1.6$ and 2.4; in both cases $\alpha_\perp$ was kept at 1.2. The measurements showed that a 2.5-fold increase in H_0 (from 3.7 kOe to 9.4 kOe) does not lead to a significant increase in the density of a stably confined plasma (with the above-mentioned dependence on H, the density should have increased by a factor of 25). As before, the slow charge-exchange decay was found to begin only at densities of $(5 \times 10^9) - 10^{10}$ cm^{-3}. In addition, it was found that the density of a slowly decaying plasma is strongly dependent on $\alpha_\perp$, i.e., on the depth of the magnetic well. When $\alpha_\perp$ increases from 1.4 to 1.7, the density rose by an order of magnitude, reaching $5 \times 10^{10} - 10^{11}$ cm^{-3}. It follows from the results that the rapid fall in density observed after injection has ceased is not associated with drift-cone instability. This instability was not detected in the experiments described, although according to theoretical predictions it should have occurred. (auth)

32327 DECAY MODES OF A DENSE PLASMA IN A MAGNETIC WELL. Coensgen, F. H.; Cummins, W. F.; Ellis, R. E.; Nexsen, W. E. Jr. (Univ. of California, Livermore). pp 225-38 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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Energetic deuterium plasmas of $\beta \approx 5\%$ are formed in an open-ended magnetic well system, using the techniques of plasma injection and magnetic compression. Containment in the quasi-dc field following compression is studied. Under ordinary vacuum wall conditions there are rapid plasma losses, accompanied by rf signals at ion-cyclotron frequencies, ω_{ci}. This activity is tentatively identified as the ion–ion instability due to a "double humped" ion energy distribution. The loss was suppressed by forming gas-free Ti surfaces throughout the chamber. Under these latter conditions, it was also shown that interchange instabilities are suppressed by the minimum-B field for densities as high as 5×10^{13} cm^{-3}. The D^+ energy distribution as derived from analysis of charge-exchange fast atoms extends from 2 to 50 keV and, following the initial containment phase, remains essentially unchanged with time. The mean ion energy of 8 keV derived from the distribution is in good agreement with the ion temperature deduced from the measured density and prompt neutron flux. The fact that the reaction rate decays as n^2 is further evidence that the energetic D^+ ions are the primary plasma component. The decay rate is at all times substantially greater than that expected from ion–ion scattering, and thus is indicative of anomalous losses. Sporadic bursts of particles through the mirrors as well as fluctuations near ω_{ci} and harmonics give direct evidence of cooperative effects at densities above 2×10^{12} cm^{-3}. The density history is divided into three periods: After compression, the decay proceeds exponentially with a characteristic lifetime $\tau \approx 200$ μs down to a density near 1.5×10^{12} cm^{-3} where the decay rate abruptly decreases so that τ increases to approximately 400 μs. At densities $\leq 2 \times 10^{12}$ cm^{-3}, the decay rate decreases markedly, so that this density remains nearly constant for periods of several hundred μs. Two or more such periods may occur, separated by periods of rapid loss so that the density history in the third period has a steplike appearance. The transition between the first and second periods appear to mark the disappearance of a strong early instability which is thought to be an ion–ion mode. Losses in the second period and between the flat sections of the third period appear in part to arise from multicomponent instabilities involving double-humping effects associated with the presence of impurity ions. (auth)

32328 CONTAINMENT OF HIGH-DENSITY PLASMA IN A PULSED MAGNETIC WELL (M.T.S.E.II). Francis, G.; Hill, J. W.; McNamara, B.; Mason, D. W. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 239-51 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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A new apparatus is now being used to study the containment of plasma trapped in a magnetic mirror or well. It follows the principle of an earlier experiment (M.T.S.E.I.) in that plasma from a coaxial gun is guided along a converging static magnetic field and trapped between pulsed mirrors energized at suitable times. The trapped plasma has a density of about 10^{13} ions/cm^3 with a mean ion energy of 15 keV. Pulsed stabilizing fields ($l = 2$ configuration) can also be applied to form a magnetic well; the field at the center of the apparatus is 2 kG, under the mirror conductors 6 kG (maximum), and the maximum depth of the well is 2.0. The important new feature of this apparatus is a very large stainless steel vacuum vessel of volume 3000 liters, inside which are disposed the conductors producing the pulsed magnetic fields. This arrangement ensures that the plasma is not rapidly destroyed by the injection of neutral gas from the walls. The object of the experiment was to determine the critical β for hydromagnetic stability of a well, and to study the mode of decay of the trapped plasma. Plasma was trapped in a simple mirror arrangement and its behavior studied by a diamagnetic loop and several devices for detecting the flux of fast neutrals due to charge exchange, sensitive to different ratios of $v_\perp/v_{||}$. The results so far achieved show that a significant fraction of the plasma is trapped, giving β values of approximately 10%; the neutral-particle detectors show clear oscillations of groups of ions between the mirrors; the containment time was about 80 μs, consistent with earlier results. Further measurements on plasma trapped in a well are proceeding. (auth)

32329 EXPERIMENTS ON PLASMA INJECTION, HEATING, AND CONFINEMENT IN STELLARATORS. Adlam, J. H.; Ashby, D. E. T. F.; Bickerton, R. J.; (and others) (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 573-90 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

A simple plasma accelerator that injects plasma across a mag-

netic field is described. It consists of two disc-shaped electrodes in the magnetic field of a long solenoid with additional helical (l = 3) windings. Gas is supplied from hydrogen-loaded titanium electrodes. An artificial line is discharged across these electrodes, producing a plasma stream crossing the magnetic field as well as spreading along the field lines. Typical parameters in the experiments to be described are an ion energy of 30 eV, a pulse length of 50 μs, a total number of ions of $\sim 6 \times 10^{15}$ in a field of 3 kG. This system has been used to inject plasma into two stellarators. The first uses a silica torus of 10-cm bore, 65-cm major diameter and an axial field of ~3 kG. External helical windings (l = 3) provide a maximum rotational transform of ~120°. Plasma is injected into this first stellarator, enabling the initial preheat voltage pulse to break down a hydrogen gas background (pressure $\sim 10^{-4}$ torr). The resulting plasma is then heated to kilovolt temperatures by inducing in it a large axial electric field (greatly exceeding the critical field for runaway). The current which flows for 1 μs is a unidirectional pulse of $\sim 10^4$ A. Large-amplitude electrostatic waves are excited; the collisionless damping of these waves leads to rapid heating of both electrons and ions. In a second stellarator, the helical winding has a minor radius of 9 cm and major radius of 40 cm. The pulsed magnetic field is ~3 kG and l = 3 windings give a rotational transform of 220° and a shear parameter $\theta \sim 6 \times 10^{-2}$. Experimental results indicate that the injected plasma is confined in this stellarator for periods of up to 15 Bohm times. (auth)

32330 COMPUTER SIMULATION OF PLASMA CONFINEMENT IN A STELLARATOR. Smith, C. G. (Princeton Univ., N. J.); Bishop, A. S. pp 591-608 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The time-dependent approach to, and stability of, low-density equilibria in toroidal geometry is studied by simultaneously integrating the guiding-center equations of motion for a vast number of particles characterized by a distribution of parallel and perpendicular energies and initial positions. A static magnetic field which models the major effect of stellarator helical windings is used for the calculation, but the self-consistent, time-evolving electric fields are included in the dynamics. Axial symmetry is imposed, but motions parallel to the magnetic field are treated since these are projected on the cross-sectional plane by the rotational transform. Consequently, the effect of mirroring and of a parallel electric field are included. In particular, the motion of electrons along field lines to cancel the charge imbalance due to curvature drifts is explicitly treated. In the single calculation performed thus far, the development of azimuthally asymmetric potential surfaces has been observed. This is primarily an m = 1 perturbation, the energy of which undergoes growth on the order of a Bohm confinement time and then slight decay thereafter. The long-term evolution occurs in the up–down (with respect to the toroidal plane) asymmetry; the in–out asymmetry, after an initial flip of sign, persists in a fashion which reinforces the trapping of electrons by the toroidal structure of the magnetic field. Superimposed are fluctuations with a period equal to the time required for electrons to move from the top to bottom of the machine by streaming along the field lines. The outward transport of electrons by $\vec{E} \times \vec{B}$ drifts is small. (auth)

32331 PLASMA CONTAINMENT IN A STELLARATOR FOR DIFFERENT FREE PATH LENGTHS. Bocharov, V. N.; Volosov, V. I.; Komin, A. V.; Panasyuk, V. M.; Yudin, Yu. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 561-72 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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Plasma decay was investigated in a stellarator with the following parameters: radius of the device R = 50 cm; chamber radius r = 5 cm; angle of inclination of the helical winding 45°; l = 3. According to theory the maximum angle of the curved field trajectory $l = 4\pi$; the measured value $l \cong \pi$. "Stochastic heating," in which a high-frequency voltage is applied across one or several sections of the metallic chamber (f = 5 Mc/s; $U_{h.f.}$ = 40 V), was used. The parameters of the plasma produced by this method are: $n = 10^9$ cm^{-3}; T_e = 30 to 300 eV; neutral atom density 10^{11} to 10^{13} cm^{-3}. The plasma decay was studied after the high-frequency generator was switched off and the electrons cooled to 5 to 10 eV. Densities of 10^9 to 10^6 cm^{-3} were measured by means of a uhf resonator. The experiments were carried out with argon and helium. The plasma decay time reduced to a constant separatrix radius $\tau' = \tau(r/r_c)^2$, where r_c is the true separatrix radius. When the electron free paths are relatively short (less than or of the same order as the perimeter of the system), the approximate empirical formula $\tau' = k_1^2 H_0^2$ can be used, where ϵ is the ratio of the helical winding current to the toroidal winding current and H is the longitudinal field. The resulting dependence of the plasma lifetime on the magnetic field and on ϵ^2 (ϵ^2 being proportional to the shear) is of the same order of magnitude as the diffusion coefficient determined by the universal (drift) instability. Correlation measurements with the help of nv probes show that oscillations with frequencies close to the drift frequency are present in the plasma. (auth)

32332 THE EXPERIMENTAL INVESTIGATION OF SINGLE-PARTICLE CONTAINMENT IN A HIGH-SHEAR STELLARATOR. Gibson, A.; Hugill, J.; Reid, G. W.; Rowe, R. A.; Sanders, B. C. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 465-78 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

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A low-β toroidal reactor will only be feasible if ions with randomly directed velocities can be contained while they make more than 10^4 transits around the trap. However, in a toroidal stellarator, because of the lack of symmetry, it has not been demonstrated that even the field lines are contained to this accuracy. Experiments to measure the confinement time for a distribution of single particles in a high shear stellarator are described here. The method used is to populate the trap with β particles from tritium gas and measure the equilibrium population by collecting all the trapped electrons on a moving scintillation probe driven across the trap. The maximum containment time that can be measured in this way is set by the energy degradation time on the background gas and can correspond to more than 10^8 transits. Those particles born in the loss region of velocity space (i.e., on to orbits which intersect the wall in a few transits) are excluded from the measurement. The trap is a stellarator with a toroidal l = 3 helical winding, minor radius 11.5 cm, major radius 30 cm, and mean pitch angle 45°; there are 8 field periods on the torus. The limiter radius is 5.8 cm and the separatrix can be inside the limiter for toroidal fields of up to 1000 G. For this field the mean ratio of limiter to Larmor radius, for particles detected by the scintillator, is about 30. The windings are designed to produce a spatially accurate, quasi-dc (~10 s) field, it is possible deliberately to perturb the field and assess the effect on particle confinement. Measurements with Hall probes on particular lines show that the field accuracy is, in fact, better than 0.3%, and electrons from guns ($V_\parallel / V_\perp$ large) lie on closed surfaces for at least 10 to 20 transits. Measurements, using tritium, show that there are regions of the trap where electrons are contained for more than 10^7 transits. (auth)

32333 CONFINEMENT OF GUN-INJECTED HYDROGEN PLASMAS AND MICROWAVE-PRODUCED XENON PLASMAS IN THE C STELLARATOR. Grove, D. J.; Meservey, E. B.; Stodiek, W.; Young, K. M. (Princeton Univ., N. J.). pp 479-96 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Confinement times of gun-injected stellarator plasmas were observed to be about five times the Bohm value. The confinement time is dependent on the current in the l = 3 helical windings. The major differences between these plasmas and those used in earlier experiments, where the density decay time was insensitive to helical-winding current and agreed with the Bohm relation within a factor two, are the much longer mean free path, the high average ion energy, and the low neutral background density. Titanium washer guns, located in the divertor, produce hydrogen plasmas of $n = 10^9$ to 4×10^{10} cm^{-3}, at $T_e \leq 10$ eV. Electron–ion mean free paths range up to several hundred machine lengths, contrasting with the earlier Bohm diffusion regimes (typically $n = 10^9$ cm^{-3}, $T_e \sim 0.3$ eV to $n = 3 \times 10^{13}$ cm^{-3}, $T_e \lesssim 100$ eV) where mean free paths were at best one machine length, and usually much less. The ratio of the observed confinement time to the Bohm value rises to a maximum of about 5 at l = 3 winding currents for which the rotational transform at the plasma boundary is approximately 2 radians. Thereafter, the ratio remains constant or decreases. The confinement time is approximately linear with β in the measured range from 1 to 40 kG. In experiments with microwave-produced xenon plasmas of $n = 10^9$ cm^{-3} and $T_e \sim 0.3$ eV, the behavior of the confinement time is similar to the gun-plasma case in its dependence on helical-winding current. The maximum ratio of the observed confinement time to the Bohm value is again about 5. In both experiments, there may be a con-

siderable difference between the observed temperature obtained from the conductivity assuming a Maxwellian distribution and the actual temperature of the bulk of the particles. It is possible that experimentally observed electrons of relatively high energy are distorting the velocity distribution so that the conductivity yields an artificially high temperature. Because of this uncertainty, no detailed comparison of the experiment is made with theoretical predictions. (auth)

32334 EXPERIMENTAL STUDIES OF ANOMALOUS RESISTIVITY AND THE ASSOCIATION OF FLUCTUATIONS AND COLLISION FREQUENCY WITH CONFINEMENT. Brown, I. G.; Dimock, D. L.; Mazzucato, E.; Rothman, M. A.; Sinclair, R. M.; Young, K. M. (Princeton Univ., N. J.). pp 497-511 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Results on the properties of ohmically heated plasmas in the C stellarator are given for a new collisionless regime and for the transition region between collisional and collisionless plasmas. In these experiments confinement times can exceed the "Bohm time" by a factor of 5. Detailed probe measurements have identified two instabilities which contribute to the plasma loss. Thomson scattering of laser light was used to check the conductivity temperature, with densities from 4×10^{11} to 10^{13} cm^{-3}, and for some interesting regimes an analogous resistivity was found. Fluctuations characteristic of the current-drive drift instability (the Kadomtsev mode) are found when $u/v_i \gtrsim 1$ and $k_\parallel \lambda_e > 1$ (where u is the electron drift velocity, v_i the ion thermal velocity, $k_\parallel$ is the parallel wave number, and λ_e the collision mean free path). For this case, the outward flux obtained from correlation of Langmuir probe fluctuations is sufficient to provide the observed loss rate. With increased shear, the confinement improves by a factor of 3. For the high-density, low-temperature regime with $u/v_i < 1$ and $k_\parallel \lambda_e \ll 1$, fluctuations characteristic of a curvature-driven resistive ballooning mode are found and here the fluctuations are insufficient to account for the loss rate. The Thomson scattering measurements show that for $u/v_e < 0.02$ the temperatures obtained from Thomson scattering agree very closely with the conductivity temperatures. (Here v_e is the electron thermal velocity.) However, in the range $0.02 < u/v_e < 0.1$, the laser-determined temperature rises steadily to v almost three times the conductivity temperature, indicating an anomalous resistivity. Studies of the transition region from short to moderately long collision mean free paths have been extended by combining ohmic heating with ion-cyclotron resonance heating. The electrons can be heated by Landau damping of the ion cyclotron waves to about 100 eV at densities of 10^{13} cm^{-3} (with ion temperatures, T_i, about 500 eV), and to 70 eV at 10^{11} cm^{-3} (with $T_i < 2\,T_e$). As λ_e is increased up to 50 axial lengths, the ratio of the observed confinement times to the computed Bohm times is a monotonically increasing function of the product of λ_e and the rotational transform, rising from unity to a maximum observed value of 5. (auth)

32335 CONFINEMENT OF CONTACT-IONIZED BARIUM PLASMA IN THE WENDELSTEIN STELLARATOR W II. Berkl, E.; Eckhartt, D.; von Gierke, G.; Grieger, G.; Hinnov, E.; von Hagenow, K. U.; Ohlendorf, W. (Institut fuer Plasmaphysik, Garching, Ger.). pp 513-28 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The confinement of low-β plasmas in a stellarator magnetic field was studied experimentally as a continuation of previous work. A new stellarator, W II, allows dc operation. It has circular shape, avoids interruptions of the helical windings generating an l = 2 helical field, and possesses five-fold rotational symmetry. It has practically no shear but a small average magnetic well, 3% in depth. Barium plasma was produced by contact ionization on a radiation-heated tantalum sphere located on or near the magnetic axis. Measurements of the density distribution were performed for various values of the magnetic field, the angle of rotational transform, and the magnitude of the input ion flux. The ion density was determined by two independent methods, namely (i) Langmuir probes and (ii) resonance fluorescence. The measured relation between input ion flux and peak ion density was in agreement with numerical calculations of this dependence assuming resistive diffusion across a stellarator magnetic field and recombination on the surfaces of the emitter and its supporting wire as well as on the surfaces of any probe introduced into the plasma. This confirmed earlier measurements done in the apparatus W Ib. For the higher emitter temperature assumed in the calculations, the flux lost on the emitter is negligibly small compared to the flux radially outwards. It was found that for input ion flux and main magnetic field kept constant, the peak ion density decreases markedly whenever $L/2\pi$ is a rational fraction. (auth)

32336 PLASMA CONFINEMENT IN THE LEVITRON. Anderson, O. A. (Univ. of California, Livermore); Birdsall, D. H.; Hartman, C. W.; Lauer, E. J.; Furth, H. P. pp 443-62 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Confinement of gun-injected plasma and anisotropic hot electron plasma is investigated in the Levitron. Field configurations are employed which have strong shear ($L_s/r_p \approx 0.1$ to 1), reversible gradient in average B, and a local minimum |B| mirror region of the Kadomtsev type embedded in the closed toroidal flux surfaces. Gun plasma is produced by either a hydrogen washer source or a lithium "Bostick" gun. For broadly optimum field configurations with maximum shear and a stagnation point on the small major radius side of the floating ring, plasma injected across the separatrix spreads at the ion directed velocity (20 to 50 eV) to form a toroidal shell several cm thick with $n \approx 10^{10}$ to 10^{11} ions/cm^3, $T_e \approx$ 5 to 15 eV. During the initial decay to $n \approx 10^9$ to 10^{10} ions/cm^3 ($t \approx 100$ to 300 μs) the plasma profile shifts inward toward the ring, accompanied by fluctuations of several kilocycles ($\delta n/n \approx 0.1$) localized in the extremal density gradient on the large major radius side of the ring. Subsequently, $\delta n/n$ decreases and the decay time increases to 1-2 ms. Bohm confinement times are exceeded by 1 to 2 orders of magnitude. If the stagnation point is shifted to the large major radius side of the ring, strong shear is retained while destabilizing field gradients are increased; comparable decay times are again observed, suggesting dominantly shear-dependent confinement. Hot electron plasma is formed by pulsed microwaves ($\lambda = 3$ cm, 5 to 20 kW, $\tau_H = 1$ to 2 msec) resonant in the minimum-|B| mirror region. The initially anisotropic and mirror confined plasma ($n_{ehot} \approx 2 \times 10^{10}$, $T_{ehot} \approx 5$ to 20 keV) subsequently spreads around the ring along B by collisions with residual gas or by end-loss instability. Under optimum adjustment of parameters, the confinement time τ_c is established by either energy loss by collisions with background gas, probe collection, or decay of the pulsed confining field. Typically $\tau_c \approx 1$ to 10 ms, consistent with τ_c several orders of magnitude $> \tau_{Bohm}$. The degree to which isotropy is approached is limited by collection on stationary probes or by the slow scattering rate. An ohmic heating current is observed for both gun and microwave produced plasmas. At 50-kA ring current, the weak ohmic current does not appreciably affect the decay of gun plasma. As the ring current is increased to 150 kA holding I_{ring}/I_t constant, a discharge forms causing a plasma density increase after gun injection or microwave heating to $n \approx 10^{11}$ to 10^{12} ions/cm^3 ($T_e \approx 20$ to 30 eV) in several ms which then decays with a time constant approaching the field decay, $\tau \approx 10$ ms. Induced ohmic current is inherent to an inductively excited resistive ring. (auth)

32337 PLASMA CONFINEMENT AND POTENTIAL FLUCTUATIONS IN A SMALL ASPECT RATIO LEVITRON. Kuckes, A. F.; Turner, R. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 427-42 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The magnetic confinement of a partially ionized, collisional plasma in a small aspect ratio levitron with considerable magnetic shear was studied. Plasmas produced in a purely poloidal field are observed to be very unstable, but with both poloidal and toroidal fields energized the plasma loss rate from the device is an order of magnitude slower than predicted by Bohm diffusion. The observations are consistent with plasma loss by diffusion at a rate inversely proportional to B. The plasma confinement does not vary explicitly with shear parameter θ between 0.05 and 0.15. Potential fluctuations are most pronounced on the outer density gradient of the plasma and have a well defined frequency which varies between 50 and 200 kHz. Their frequency is well correlated with that of drift oscillations ($\omega^* = k_\perp \kappa\, T_e/eB\, 1/n_e\, \delta n_e/\delta_x$) if $k_\perp$ is assumed to be the reciprocal of the plasma gradient length. The maximum rms value of these oscillations is about $0.05\,\kappa\, T_e/e$. (auth)

32338 LINEAR MULTIPOLE AND SPHERATOR EXPERIMENTS. Yoshikawa, S.; Barrault, M.; Harries, W.; Meade, D.; Palladino, R.; von Goeler, S. (Princeton Univ., N. J.). pp 403-25 of Plasma Physics and Controlled Nuclear Fusion Re-

search. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Plasma containment and fluctuations are being studied in magnetic field configurations with strong stabilizing and symmetry properties. For this purpose, a multipole device with linear conductors (LM-1), and a toroidal single-ring device (spherator) were constructed. The LM-1 facility operated as a quadrupole, generally in the collisionless regime, with $n = 10^{10}$ to 10^{12} cm^{-3} and T = 1 to 10 eV. Plasma production by rf ohmic heating and resonant microwave heating was used for $T_i \ll T_e$; and gun injection for $T_i \gtrsim T_e$. Both high-frequency fluctuations with $k_{||} \neq 0$, and low-frequency, $k_{||} = 0$ modes were observed inside the $\int dl/B$-stable region. The structure of the high-frequency mode fits the theory of drift-type ballooning. It is suppressed by a weak axial field. The low-frequency fluctuation, which may be related to the trapped-particle mode, is suppressed by $T_i \gtrsim T_e$. The plasma profile on the minimum-B (conductor) side is always quiescent. The observed confinement times (typically 1 to 2 ms) are limited mainly by radial (outward) plasma loss in the $T_i \ll T_e$ case, and mainly by axial loss in the $T_i \gtrsim T_e$ case. In the first case, the confinement time is typically ten times Bohm. In the second case, the confinement time as calculated from the radial loss corresponds to approximately fifty times Bohm. The radial transport in LM-1 is not, in general, well correlated with the fluctuations, and one deduces the existence of additional loss mechanisms. Stationary convective cells were identified in the case of ohmic heating, where the coil structure initiates and maintains a spatial periodicity. Their relevance to the anomalous transport is being studied. The spherator experiments were performed in density and temperature ranges similar to LM-1. Fluctuations can be suppressed throughout the density profiles under certain conditions of plasma parameters. Plasma confinement times were measured to be 2 to 25 ms and the particle loss is mainly to supports of the centering under typical conditions. Under best conditions, support loss accounts for more than 95% of the total particle loss. In terms of Bohm confinement times, the typical confinement times calculated from the loss other than to supports are ten times Bohm, but under optimum conditions confinement times reach 40 times Bohm. A center ring with reduced support area is being substituted, and a superconducting ring has also been tested, for later operation. (auth)

32339 PLASMA CONFINEMENT IN A TOROIDAL OCTUPOLE MAGNETIC FIELD. Forsen, H.; Kerst, D.; Lencioni, D.; Meade, D.; Mills, F.; Molvik, A.; Schmidt, J.; Sprott, J.; Symon, K. (Univ. of Wisconsin, Madison). pp 313-28 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The confinement of low-density ($n = 10^9$ cm^{-3}) collisionless plasmas with $T_i \simeq 40$ eV, $T_e \simeq 10$ eV produced by gun injection or with $T_e \simeq 1$ eV, $T_i < 1$ eV produced by microwave heating was studied to determine the mechanisms for plasma loss from an inductively excited, mechanically supported toroidal octupole. The decay time for the hot ion plasma was ≃700 μs, while the lifetime for the cold ion plasma was about 3 times longer. Particle-collector measurements indicated that most of the particles were lost on the hoops and their supports for both types of plasma. Direct measurements of the radial particle loss to the outside wall using a large azimuthally symmetric screened collector outside the MHD stable region indicated that roughly 15% of the hot ion plasma and ≤2% of the cold ion plasma was lost radially during the quiescent confinement period. The amplitude of the fluctuations (1 kHz to 1 MHz) in the MHD stable region implied a turbulent diffusion coefficient; the order of 10^{-3} of the Bohm diffusion coefficient which was not large enough to produce the observed radial loss. Studies were also made to determine the importance of low-frequency fluctuations or convective cells that may have been produced by injection, magnetic field perturbations, or azimuthal density variations. The addition of a toroidal magnetic field decreased the lifetime slightly and generated large-scale convective cells in the shearless layer near the plasma surface. Currents parallel to the magnetic field were observed, which must be considered in determining the cause of increased fluctuation with the increase of the toroidal field. The mechanical supports were also guarded with magnetic dipoles in the manner proposed by Lehnert. The plasma flux to one of the supports was reduced for the hot ion plasma by an order of magnitude when there was one ion gyroradius between the mechanical support and the guard field separatrix. However, the plasma flux along the guard field separatrix increased to the value of the original support flux and there was a negligible (≤20%) improvement of the lifetime. An inductively excited, magnetically force-free octupole is being assembled with transiently withdrawn supports to eliminate the plasma loss to hoop supports. The device will provide at least 10 msec of experimental time during which only 5% of the magnetic flux diffuses into the internal hoops. 100-eV protons will have 15 gyroradii on each side of the separatrix. (auth)

32340 PLASMA COMPRESSION STUDIES IN THE "TUMAN" DEVICE. Golant, V. E.; Gladkovskii, I. P.; Kalmykov, S. G. (Leningrad Inst. of Physics and Tech.). pp 277-85 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

Ohmic heating and adiabatic compression of a plasma by a magnetic field in the "Tuman" device are described. A conducting line was installed in the toroidal sections of the dielectric discharge chamber, leading to an increase in plasma temperature and in the degree of plasma ionization. The plasma is compressed by a magnetic field which rises to a maximum of 10 kOe in 20 μs. By means of uhf location it is found that compression is accompanied by effective detachment of the plasma column from the walls of the discharge chamber and the diaphragm. The plasma density near the diaphragm is less than 5×10^{12} cm^{-3} during compression. Compression is accompanied by substantial plasma heating; when the amplitude of the compressing field is 10 kOe the plasma conductivity rises by a factor of 5 to 8, which corresponds to an increase in electron temperature from 7 to 10 eV to 30 to 40 eV. The increase in plasma temperature is due to adiabatic compression and to an increase in the efficiency of ohmic heating. When the plasma is compressed the energy containment time increases by a substantial factor to 20 to 40 μs. This is accompanied by a sharp decrease in the intensity of the H_β line, indicating a decrease in the neutral concentration, which is estimated at $\sim 2 \times 10^{12}$ cm^{-3} during compression for a plasma density $\sim 10^{15}$ cm^{-3}. (auth)

32341 COLLISIONLESS SHOCK WAVES AND TURBULENT HEATING IN HIGH VOLTAGE THETA PINCHES. DeSilva, A. W.; Duechs, D. F.; Goldenbaum, G. C.; Griem, H. R.; Hintz, E. A.; Kolb, A. C.; Kunze, H.-J.; Vitkovitskii, I. M. (Univ. of Maryland, College Park). pp 143-53 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

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Based on preceding experiments with smaller systems, a large (46 cm diameter, 100 cm length) theta pinch was constructed which is driven by a Blumlein-type transmission line (~0.4Ω) capable of generating a 1 MV pulse (open circuit) of 100 ns duration. For the experiments described here, it was operated at 40% of design voltage. The corresponding peak field is 3.2 kG, and a strong shock wave (5×10^7 cm/s) is generated in the initial plasma containing a (parallel or antiparallel) bias field. This initial plasma is prepared in typically 5-mtorr D_2 by a sequence of auxiliary discharges through the theta-pinch coil. Shock structure and the field–vacuum interface are investigated (mainly by magnetic probes). These measurements, besides being compared directly with theoretical predictions, also yield current densities required for the determination of effective (turbulent) electrical conductivities from measured electron heating rates (using x-ray emission). Ion energies are estimated from neutron yields. Indications are that there is an anomalous ion heating mechanism, in addition to anomalous electron heating, as observed in preceding experiments from Thomson scattering measurements. In parallel with these laboratory investigations, a computer simulation program was developed that permits quantitative discussion of the influence of nonstationarity and cylindrical convergence on the experimental results and of the deviations from classical results caused by anomalous transport processes (with coefficients either estimated theoretically from growth rates of expected microinstabilities or chosen to fit the experimental results). (auth)

32342 EXPERIMENTS IN TOKAMAK DEVICES. Artsimovich, L. A.; Bobrovskii, G. A.; Gorbunov, E. P.; (and others) (Moscow Inst. of Atomic Energy). pp 157-73 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Recent investigations carried out with magnetic fields of 9 to 35 kG in the Tokamak devices T-3 and TM-3, presenting new data on the conditions of plasma column equilibrium, the energy balance, and the containment time of particles in the plasma column are described. The total ion and electron temperature is deter-

mined by measuring the diamagnetism of the plasma and the radiointerferometric broadening of the plasma density. The electron temperature is estimated independently by measuring the soft x-ray emission spectrum, and the ion temperature by analyzing the energy spectrum of the charge-exchange atoms. The density of the plasma electrons varies between 10^{12} and 5×10^{13} cm^{-3}. The electron temperature lies within the range 100 to 2000 eV, while the ion temperature reaches ~300 eV. The energy containment time τ_E characterizing the confinement of the plasma is given. An attempt is made to find an empirical formula linking τ_E with the basic parameters characterizing the state of the plasma. It is shown that τ_E increases with the amplitude of the discharge current pulse and is independent of the longitudinal magnetic field as long as the plasma column is magnetohydrodynamically stable. The maximum value of τ_E is ~10 ms. At high temperatures τ_E differs significantly (by a factor of up to 50) from the value given by Bohm's formula. Anomalously high plasma resistance is observed in cases of large currents and low electron densities. The charged-particle containment time is determined by measuring the rate of ionization of the neutral hydrogen atoms entering the plasma column during the discharge and the variation in plasma electron density over time. It is found to be several times greater than the energy containment time τ_E. (auth)

32343 SELF-CONSISTENT KINETIC MODEL FOR TWO-DIMENSIONAL CUSPED AND MINIMUM-B TYPE EQUILIBRIA. Sestero, A.; Giupponi, P. (EURATOM-CNEN, Frascati, Italy). Phys. Fluids, 12: 1305-11(June 1969).

Plane quadrupolar cusp containment is studied in terms of the Vlasov equation for ions and electrons. The treatment applies both with and without a constant magnetic field component normal to the considered plane (respectively, minimum-B type and pure-cusp type confinement). Under certain assumptions, the problem reduces to an elliptic nonlinear partial differential equation of the second order with Dirichlet boundary conditions, which is investigated numerically using standard relaxation methods. Solutions are found with cusp width as small as the electron Larmor radius; if the field lines are short-circuited, however, the smallest cusp width is of the order of the ion Larmor radius. The plasma outflow through the cusps is also computed, and the results are discussed. (auth)

32344 OBSERVATION OF COLLISIONLESS PLASMA HEATING BY STRONG SHOCK WAVES. Keilhacker, M.; Kornherr, M.; Steuer, K.-H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 223: 385-96(1969).

The heating of a plasma by collisionless shock waves is investigated by measuring the variation of magnetic field (with magnetic probes), density and electron temperature (from Thomson scattering of laser light) in the shock waves. The compression waves are produced in a tube of 14-cm diameter by the fast rising magnetic field (12 kG in 0.5 μsec) of a theta pinch. For shocks with Mach numbers between 2 and 3 propagating into a hydrogen or deuterium plasma with a local β of about 1 (β = ratio of particle pressure to magnetic pressure) the measured jump in density and magnetic field across the front is 2 to 4, and the electron temperature increases in the front from 3 to 50 eV with a further rise to between 100 and 250 eV in the piston region. Only about 20% of the measured electron heating can be explained by adiabatic heating and resistive heating based on binary collisions, indicating a high turbulent plasma resistance. Both the observed electron heating and the width of the shock front, which is about $0.6 \cdot c/\Omega_p$, can be accounted for using an effective collision frequency close to the ion plasma frequency Ω_p. The ion heating in the almost stationary shock fronts can be inferred indirectly from the steady-state conservation relations. For shock waves with Mach numbers $M < M_{crit}$ it seems to be consistent with an adiabatic heating process, whereas for $M > M_{crit}$ the calculated ion temperatures exceed those one would except for a merely adiabatic heating. (auth)

32345 DYNAMICS OF PLASMA HEATING IN A TURBULENT LINEAR DISCHARGE. Berger, N. K.; Koidan, V. S.; Papyrin, A. N.; Ponomarenko, A. G.; Stibunov, V. N.; Yablochnikov, B. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz., 56: 1463-79(May 1969). (In Russian).

Results of investigation of plasma heating by the current of a linear discharge are presented. The development of turbulence is investigated by means of Langmuir probes, an electrostatic analyzer, and diamagnetic and x-ray detectors. It is shown that the appearance of an anomalous resistance and the maximal absorbed energy in the plasma depend on the density and temperature of the preliminary plasma. A characteristic feature of the strong turbulence phase is that the main potential drop tends to concentrate in a definite region of the plasma column; the most intense high-frequency oscillations also occur in this region. The maximum values of the anomalous resistance and voltage across the discharge are observed during the sharp drop of the current. A reverse electron current towards the cathode appears at the same time. Turbulent conditions are characterized by expansion of the plasma column towards the chamber walls. The possible causes of the effects are discussed. (auth)

Diagnostics

32346 (CEA-CONF-1276) HOLOGRAPHIC CAMERA IN THE NANOSECOND RANGE. Buges, J. C.; Terneaud, A. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes Nucleaires). [1969]. 2p. (CONF-690315-1). Dep.

From Conference on Lasers and Optoelectronics, Southampton, England.

A brief description is given of a holographic camera that gives ten images, the exposure time of which is one nanosecond. (M.O.W.)

32347 (IPP-1/93) INVESTIGATION OF THE ION ENERGY DISTRIBUTION IN A STRONG COLLISION-FREE COMPRESSION WAVE. Schumacher, U. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1968. 68p. (In German). Dep.

In a strong collisionless implosion wave generated by a very fast theta-pinch discharge, the density profile and the distribution of ion energies were investigated by spectroscopic methods. The density profile was found to be as extended as the current-carrying layer, which is determined by the overturning of the ion sheath. By this mechanism, an effective thermalization of the ions in the plane perpendicular to the magnetic field leads to undirected ion energies up to 500 eV, which are comparable with the energy of the directed ion motion. However, the thermal ion energies parallel to the direction of the magnetic field are lower by more than a factor of 2. The ion energy anisotropy is especially pronounced at low initial pressures (20 mtorr D_2). This anisotropy may not be destroyed by ion two-stream instabilities, but possibly by anisotropy instabilities. (auth)

32348 (NP-17903) STUDY OF THE VARIATION OF ELECTRON TEMPERATURE AND ELECTRON DENSITY IN A PLASMA UNDER HF ELECTRIC EXCITATION. Saint-Martin, Christian (Toulouse Univ. (France). Faculte des Sciences). 1969. 90p. (In French). Dep.

Thesis.

Using multiple floating probes, of which the theory has been adapted to the case of high-frequency electrical discharges, the variation of the electron temperature and density was studied. The abnormal evolution of electron density is linked to the existence of two discharge regimes. The dark regime is characterized by a weak density. A higher density corresponds to the bright regime, as well as a stronger luminosity. The passing from one regime to another occurs suddenly, and is accompanied by a change in the evolution of the electron density. A theoretical study carried out, starting from the resonant discharge theory, takes into account this abnormal variation of the electron density at the time of a change in the regime. (auth)

32349 MEASUREMENT OF ELECTRON DENSITY OF A CYLINDRICAL PLASMA COLUMN BY LONGITUDINAL RESONANCES OF SURFACE WAVES. Stoichev, T.; Zhelyazkov, Iv.; Nikolov, N. God. Sofii. Univ., Fiz. Fak., 61: 85-92(1966-67). (In Russian).

A simple method is described for determining the electron density of a cold plasma column based on longitudinal resonances of axially symmetric plasma surface waves. Surface waves with a frequency range 100 to 300 MHz are excited and detected with a Q meter. A simplified dispersion equation for ω_p^2/ω_2 as a function of half wavelength ($L = \lambda/2$) of the surface wave is given. Values of the ratio ω_p^2/ω^2 are shown, calculated from the dispersion equation, for standard glass tubes of Rasoterm ($k_g = 4.40$). The function ω_p^2/ω^2 (L) is presented graphically for these cases. From the curves one can obtain the value of ω_p^2/ω^2 at given L, for the fixed frequency ω, it is possible to calculate the mean electron number density n_e. The experimental results obtained by this method are in good agreement with the data of the mean electron number density measured by the microwave-cavity perturbation method. (auth)

32350 ENHANCED PLASMA OSCILLATIONS OBSERVED WITH SCATTERED LASER LIGHT. Ringler, H.; Nodwell, R. A. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett., 29A: 151-2(Apr. 21, 1969).

A profile of the light scattered from an arc discharge has been measured. This shows a 25% enhancement at the central wavelength and 10% enhancement at a point corresponding to the plasma frequency. Here is also some indication of enhancement at harmonics of the plasma frequency. (auth)

32351 VARIATION OF THE RATIO OF DISTANT/CLOSE COLLISIONS IN A SPARK PLASMA. Voeroes, T. (Univ. for Technical Sciences, Budapest); Petrakiev, A.; Kluge, K.; Koernyei, I. God. Sofii. Univ., Fiz. Fak., 61: 131-8(1966-67).

Plasma densities and temperatures for S, K, Ca, Sc, Ti, and Hg in spark discharges were determined. Theoretical and experimental data are discussed. (M.O.W.)

32352 MULTIGRID ENERGY AND MASS ANALYZER FOR PLASMA DIAGNOSES. Inoue, N.; Leloup, C.; Uchida, T. (Nagoya Univ., Japan). J. Mass Spectrom. Ion Phys., 2: 85-91(Jan. 1969).

The energy distribution of ions in a laboratory plasma is obtained directly in a short time by applying a sawtooth voltage to a multigrid energy analyzer. Measurements of time-of-flight of ions in a multigrid analyzer with a field-free drift tube give the mass spectrum in the plasma. These analyzers can be used in a magnetic field of relatively high intensity, but parallel to their axis. (auth)

32353 DEVELOPMENTS IN THE METHOD USED FOR THE DETERMINATION OF MAGNETIC PROBE CHARACTERISTICS. Sinman, Ayten (Istanbul Univ.). Istanbul Univ. Fen. Fak. Mecm., Seri C, 32: 107-23(Jan.-Oct. 1967).

In this study, the method of measurement used previously (J. Sci. Instruments., 42: 147(1965)) was applied to a larger frequency region. Instead of the AF 115 transistor used in the large-band amplifier circuit in said method of measurement, use is made of an AF 139 transistor with a parameter Y 21 remaining constant in a larger frequency region. Accordingly, variation of probe signals with frequency between 10 kc and 50 Mc was studied by means of quenching resistors and it was found that with R_2 = 1.15 K resistor, the plot was straight between 10 kc and 4 Mc and different by ±0.8 dB with respect to the horizontal section between 4 and 10 Mc. No substantial difference was observed between the curves plotted and the curves previously obtained. However, it was determined that the resonance frequency of the circuit may be shifted from 10 to 50 Mc and may readily be measured with the present system when a probe of different characteristics is used. Furthermore, the variation of the signals of the probe with varying frequency was studied within a larger frequency band. To this end, a class-C rf power amplifier was developed and the experiment repeated by varying the angles between the probe axis and the axis of the solenoid producing the high-frequency field. It was found that the locus of the signals between 0 and 90° and 25 to 318 kc was a circle, and the radii of such circles increased linearly with increasing frequency. (auth)

32354 SPECTROSCOPIC STUDIES OF A LASER-PRODUCED PLASMA IN HELIUM. Braerman, W. F.; Stumpfel, C. R.; Kunze, H.-J. (Army Ballistic Research Labs., Aberdeen Proving Ground, Md.). J. Appl. Phys., 40: 2549-54(May 1969).

A highly ionized plasma was produced by laser-induced breakdown in helium at a pressure of 360 torr. Line and continuum emission from the plasma were studied as a function of time and of position along the axis of the laser beam. Plasma parameters were then deduced from Stark widths, line-to-continuum, and line-to-line intensity ratios. The applicability of the various methods used to the case of a rapidly decaying laser-produced plasma is discussed. The decay of the plasma is analyzed and the observed decay coefficients are compared with theoretical calculations. (auth)

32355 MEASUREMENTS OF THE ION ENERGY DISTRIBUTION FUNCTION AND THE DENSITY PROFILE IN STRONG SHOCK WAVES. Schumacher, U. (Institut fuer Plasmaphysik, Garching, Ger.). pp 93-101 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

In a theta-pinch discharge, a strong implosion wave is produced by a rapidly rising magnetic field ($dB/dt \geq 10^{11}$ G/s, zero bias field), resulting in ion energies in the keV region at the first maximum compression. This compression wave in deuterium is investigated spectroscopically to get information about the density profile and the velocity distribution function of the ions inside the imploding sheath. Because of the relatively low electron temperature (compared with the high ion energies) measurements of the Balmer line broadening are possible. The electron density profile is obtained from the Stark broadening of D_β. At filling pressures of $p_0 \leq 20$ mtorr D_2, a very broad density profile is found with maximum electron densities of some 10^{15} cm^{-3} in the outer parts of the imploding sheath. The electron density reaches a peak of 10^{16} cm^{-3} at the end of the first implosion, as has also been found from laser scattering. At a filling pressure of 60 mtorr, the maximum electron density is reached in the inner parts of the imploding layer. These measurements of the width of the imploding sheath are in agreement with those made with magnetic probes for the current-carrying layer. Time- and space-resolved measurements (side-on and end-on) of the Doppler broadening of D_α gave information about an anisotropic velocity distribution of the deuterons. For a 20-mtorr discharge (for example, in the density maximum of the imploding sheath) an undirected motion of nearly 400 eV was found to be superimposed on the radially directed imploding motion with kinetic energies of 550 eV. The ion energies parallel to the magnetic field, however, have a thermal component of only 120 eV and a mean kinetic part of about 60 eV. These results for the space-resolved ion velocity distribution function agree well with the data obtained from the spatially integrated measurements of the neutron emission at the end of the first implosion. For 60 mtorr discharges the thermal energies in the perpendicular and parallel directions do not differ as much as in the case of lower pressures. (auth)

32356 ELECTRON GROUPS, THEIR TEMPERATURES, AND DENSITIES IN THE H_2-NEGATIVE GLOW DETERMINED BY DIFFUSION AND RECOMBINATION. Franck, G.; Schlosser, E. (Univ., Munich). Z. Phys., 224: 222-36(1969). (In German).

Investigations of plasma parameters in the H_2 negative glow were made in the pressure range 0.06 to 0.6 torr. With the help of heated plane and cylindrical probes, group character of the velocity distribution of electrons was found. The electron temperature of the slow group was almost 600°K. The density of the slow group shows that there must be strong volume recombination in H_2. With increasing pressure one finds that the group character vanishes. (auth)

32357 PLASMA DIAGNOSTICS AND ELECTRODE MATERIAL RELEASE IN HIGH VOLTAGE VACUUM BREAKDOWN. McCall III, Tristram Bethea. Gainesville, Fla., Univ. of Florida, 1968. 209p.

Thesis.

Investigations of material release phenomena for electrodes undergoing high-voltage vacuum breakdown were performed using various techniques, including neutron activation analysis of the released mass. In particular, the quantity of electrode material released for specific conditions was measured. In addition, the characteristics of the release phenomena concerning the material state as well as the dynamics and direction of the material ejection were determined. From the experimentation it was concluded that the material-capture technique and neutron-activation techniques performed satisfactorily. The most probable material release mechanism is evaporation, which must occur since the electrode surfaces become molten during the vacuum breakdown. For aluminum and high-energy breakdowns there are thermal explosions at the surface which eject molten droplets. (TSS) (Disser. Abstr.)

32358 RELAXATION METHOD FOR DETERMINING THE NATURE OF CONTINUUM IN NONEQUILIBRIUM ARC DISCHARGES. Aleksandrov, V. Ya.; Gurevich, D. B.; Podmoshenskii, I. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 378-80 (Nov. 1968).

Translated from Opt. Spektrosk., 25: 674-8(Nov. 1968).

A relaxation method is proposed for separating the continuous spectrum of electron–ion recombination from the bremsstrahlung spectrum in nonequilibrium discharge plasma. The continuous spectrum of arcs burning in atmospheres of Ar, He, and He + H_2 is investigated. The applicability of this method is verified by these investigations. It was established that continuous arc spectrum in He and He + H_2 at p = 1 atm and I = 5 A is determined by the retardation of electrons by atoms. (auth)

Kinetics (General)

32359 VYSOKOCHASTOTNYE SVOISTVA PLAZMY. VYPUSK 3. (High Frequency Properties of Plasma. Volume 3). Tolok, V. T. (ed.). Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza. (Plasma Physics and Problems in Controlled Thermonuclear Synthesis). Kiev, Naukova Dumka, 1968. 224p.

Twenty-two articles are included on high-frequency properties of plasma. High-frequency plasma heating, propagation of electromagnetic waves in magnetoactive plasma, microwave methods in plasma diagnostics, magnetohydrodynamics and shock waves, and charged-particle interactions with electromagnetic waves are discussed. (R.V.J.)

32360 UDARNYE VOLNY V REAL'NYKH GAZAKH. (Shock Waves in Gas Plasma). Predvoditelev, A. S. (ed.). Moscow, Izdatel'stvo Nauka, 1968. 199p.

Experimental data covering complex problems related to shock wave propagation at high temperature are presented. The following are discussed: shock-wave parameter measuring methods, deflection of gas flow in a channel from ideal flow, gasdynamic parameters of flow behind the shock wave in a relating gas, propagation of small perturbations in the gas, and normal and mach reflection of detonation and shock waves. The ionization structure of shock waves in air and nitrogen is discussed. 283 references. (R.V.J.)

32361 PROPERTIES OF THE DENSE PLASMA PRODUCED IN PLASMA FOCUS. Peacock, N. J.; Wilcock, P. D.; Speer, R. J.; Morgan, P. D. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 51-65 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The plasma produced by the focus or quasi-cylindrical magnetic compression that occurs at the open end of a metal-walled, coaxial plasma gun was studied, using the electrical waveforms and the electromagnetic and reaction particle emission. The electromagnetic radiation in the xuv region of the spectrum has previously been briefly reported, and the present paper describes further more-detailed analyses of the line emission at wavelengths shorter than 10 Å when impurities are added to the gas filling. The emission is characteristic of a plasma with a temperature of a few keV and a density greater than 10^{19} cm^{-3}, while the appearance of optical transitions in highly stripped ions, e.g., Ar XVII, gives a measure of the thermalization in the plasma. The stored electrical energy has been doubled and the scaling of the neutron emission with the applied voltage and the initial particle density is presented. The duration of the neutron and x-ray emission is considerably longer than the observed instability growth time in the plasma filament. Calculations of the mode of heating and the confinement of the plasma are compared with experimental observations. (auth)

32362 TIME BEHAVIOUR OF SPECTRAL LINES AND DYNAMICS OF PROCESSES IN THE ROD PLASMA INJECTOR (RPI). Gryzinski, M.; Nowikowski, J.; Suckewer, S. (Inst. of Nuclear Research, Warsaw). pp 87-96 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Within the framework of research on the production of hot plasma of densities and energies required by thermonuclear investigations, a new type of injector was developed. The operational principle of the injector lies in the substitution of solid electrodes of a coaxial plasma gun by grid-type electrodes which being "penetrable" for particles, ensure their free radial motion. This alteration enables a strong concentration of plasma at the injector axis to be achieved. To explain the physical processes occurring in the active volume (that is, in the volume contained between two coaxial rims of the rods, where the electric field E_r and the magnetic field B_θ exist) and in the passive space (outside the cylindrical volume between the electrodes, where the plasma moves inertially), radiation measurements of the spectral lines were performed. The measurements were carried out with a monochromator with a photomultiplier. Air, mostly at pressures of 10^{-2} and 10^{-4} torr, was used as a test gas. The data obtained allow conclusions to be drawn on the role of the impurities evolving from the electrodes and the efficiency of gas removal from the injector volume. On the basis of the data concerning the intensities of spectral lines, the electron concentration and the time behavior of electron temperature were calculated. In the experiments performed, the electron densities were found to be of the order of $10^{15}/cm^3$, and the electron temperatures were of the order of 6×10^4°K. The "transparent" structure of the RPI electrodes allowed some conclusions concerning the processes which occur in the conventional coaxial gun since the phenomena in the two devices are almost identical at relatively high pressures. (auth)

32363 TIME RESOLVED BEAM DISTRIBUTION FUNCTIONS IN A BEAM-PLASMA EXPERIMENT. Cabral, J.; Hopman, H. J.; Insinger, F. G.; Ott, W. (FOM-Inst. for Atomic and Molecular Physics, Amsterdam). pp 749-62 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Cyclotron instability and its harmonics appear under certain conditions in injection machines, whether the injection is parallel to the axial magnetic field B_0 (Demirkhanov and Alexeff at the Culham Conference) or perpendicular to B_0 (DCX, Phoenix experiments). Measurements are described on these instabilities, around the transition from the first to the second regime. This experiment is characterized by a rapid alternation of different instabilities and plasma density and temperature changes with each instability. Investigations of these variations have only recently been forthcoming (Kharchenko, Seidl, Hopman at the Conference on Ionized Gases, Vienna, 1967). Main results here are the distribution functions of the beam electrons, correlated with the different types of instabilities. Drastic changes in the distribution function are found. In the second regime, the distribution function of axial energies jumps between a narrow plateau between 0.6 and 1.1 eV_b, and a wide plateau extending from 0 to 1.4 eV_b. These plateaus develop in about 100 ns. The wide plateau is found in correlation with an instability whose frequency is twice the electron cyclotron frequency. The narrow plateau is established by the electron cyclotron instability. Only the plateau belonging to the electron plasma instability is symmetric around eV_b; it has a width of 0.1 eV_b. In all three cases the plateaus are found to be flat, independent of their width, and of the radius on which they are measured. In correlation with the cyclotron instability are found beam electrons with transverse energies of the order of 0.3 eV_b, indicating the possibility to build up a high-energy electron plasma directly from beam electrons, in cases where a magnetic bottle is applied. In connection with the experimental data, numerically calculated dispersion diagrams are presented for bounded beam-plasma systems including temperature effects. (auth)

32364 TURBULENT PLASMA IN A STELLARATOR AND MASS-ENERGY INVESTIGATIONS OF A PLASMA TRAPPED IN A DIVERTOR APERTURE DURING INJECTION THROUGH A MAGNETIC SLIT. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; (and others) (Kharkov Inst. of Physics and Tech.). pp 543-60 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Investigations were made concerning the current-induced heating and containment of a plasma in the "Sirius" stellarator. Particular attention was paid to those oscillatory processes in the plasma which might be important in determining both the heating efficiency and the rate of energy and particle loss. After adjusting the magnetic system of the stellarator by multipole transmission of an electron beam, the dependence of the plasma decay rate on the initial plasma density, the intensity of the containing field, and the current were investigated. It is shown that the stellarator functions as a trap only when the gas-kinetic pressure of the plasma $nkT < \beta H^2/8$, the plasma decay time as determined by interferometer measurements being directly proportional to the intensity of the magnetic field and inversely proportional to the electron temperature. This relationship may be due to drift instabilities. Investigations of low-frequency oscillations using Langmuir probes show that, in a plasma produced by a current discharge, oscillations with frequencies $\omega \sim (cT/eH)(n'/n)$ are indeed excited. The spectra of these oscillations are derived and the dependence of the frequency on the magnetic field intensity and the temperature is found. Investigations of the current-induced heating of the plasma in a stellarator, for widely varying values of the electric field induced in the plasma column, show that there are regions of highly anomalous electric conductivity. In these regions, microwave and x-ray emission are observed, together with a large difference in temperature as determined by measuring the conductivity of the plasma and the diamagnetic effect. These observations cannot be explained on the basis of the classical collisional theory of current-induced heating. Thus, it is shown that during the formation and heating of a plasma in a stellarator collective oscillations are excited over a wide range of frequencies. Complete understanding of the processes of energy input and loss can be achieved only if one takes into account these phenomena, which are still insufficiently understood by the theoreticians. Using a Thomson mass spectrograph and a time-of-flight mass spectrometer, studies were made of the energy spectra, mass composition, and other parameters of a plasma trapped in a divertor aperture during injection through a magnetic slit from a coaxial plasma gun (magnetic field intensity in the divertor mirrors 1.5 to 20 kOe). It is shown that there is a magnetic field intensity (8 to 12 kOe) at which capture of the hydrogen ions along the magnetic field lines near the axis is optimized. Optimum capture of high-energy hydrogen ions occurs for approximately the same range of magnetic field intensities. (auth)

32365 THEORY AND BASIC PHENOMENA. Trocheris, M. (CEA, Fontenay-aux-Roses, France). pp 33-9 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Papers dealing with basic phenomena such as collisionless dissipative processes, waves, and microinstabilities are summarized. (M.O.W.)

32366 DEVELOPMENT OF A COLLISIONLESS SHOCK WAVE PROGRAM. Alikhanov, S. G.; Alinovskii, N. I.; Dolgov-Savel'ev, G. G.; (and others) (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 47-68 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The results obtained in investigations of the different types of collisional shock wave found in a plasma are discussed. For a wide range of plasma parameters all types of laminar waves occurring in a dilute plasma were investigated. The turbulent processes that can occur inside a collisionless shock wave front under different conditions were studied. The measured thickness of the wave front is found to agree with theoretical predictions based on turbulence models. The electron and ion components of the plasma behind the wave front are measured. (auth)

32367 INVESTIGATION OF TURBULENT PROCESSES IN THE FRONT OF A SHOCK WAVE IN A PLASMA. Es'kov, A. G.; Kurtmullaev, R. Kh.; Malyutin, A. I.; Pil'skii, V. I.; Semenov, V. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz., 56: 1480-91(May 1969). (In Russian).

Results of investigation of microfluctuations of an electromagnetic field and the distribution of the electric and magnetic fields in the front of a shock wave are presented. It is found that electric field oscillations arise within the front when the plasma concentration increases. Their frequencies and wave lengths are consistent with the assumption of an ion-acoustic nature of the oscillations. The electric and magnetic field distributions, fluctuation level, and measured value of the conductivity in the wave are in accordance with the assumption that resistive dissipation due to "friction" between the electrons and ion-acoustic waves is dominant in the wave front. The experimental data are in agreement with the hypothesis that at $M > M_c$ the viscosity dissipation mechanism is operative; this dissipation is due to buildup of electromagnetic oscillations in opposite ion beams and is accompanied by ion heating. (auth)

Kinetics (Experimental)

Refer also to abstracts 32139, 32156, and 32861.

32368 (NP-17892) DETECTION AND ANALYSIS OF INDUCED EMISSION IN ARGON PINCH DISCHARGES. Preprint No. 184. Vasil'eva, A. N.; Zaremba, V. B.; Likhachev, V. M.; Rabinovich, M. S.; Sutovskii, V. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 61p. (In Russian). Dep.

Pinch discharges are first discussed, considering experimental installations, electrical characteristics of the discharge, optical measurements, and the mechanism of the pinch-discharge development. The induced emission in pinch-discharge plasma is then considered, taking into account generation in Ar^+ ions of emissions of 4765 and 4880 Å, and the intensity of generation as a function of initial pressure in the discharge chamber, the diameter and rate of current increase, the generation appearance moment, and the duration and time characteristics of the pinch discharge. The generation in Ar^{2+} of emissions of 3511 and 3638 Å, the moment of appearance and the duration of generation, intensity and maximum frequency of induced emission pulses are discussed, as well as preliminary ionization of the gas and the energy of emission. (R.V.J.)

32369 (SU-IPR-276) INTERACTION OF A CYLINDRICAL BEAM WITH A PLASMA. PART II. EXPERIMENT AND COMPARISON WITH THEORY. Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). Jan. 1969. Contract AT(04-3)-326. 49p. Dep. CFSTI.

Measurements were made on a beam-plasma system under particularly simple and well-defined conditions. The system could be operated at will in three distinct regimes, namely (i) a quiescent steady-state regime, (ii) a linear growth regime, and (iii) a nonlinear regime. The characteristics of the steady state are shown to agree with a static theory for a beam-generated plasma. Measurements of spatially growing waves in the linear regime are described and compared with the theory discussed in Part I. Reasonable agreement is found when the effects of finite beam radius and collisions are taken into account, but it is indicated that the effect of radial inhomogeneity is also important. Some preliminary measurements on the nonlinear regime are reported and discussed in terms of the available nonlinear and quasi-linear theories. The latter are criticized on a number of grounds as being too idealized to account for the nonlinear behavior of real beam-plasma systems and suggestions are made concerning those respects in which modifications are necessary. (auth)

32370 (SU-IPR-288) LOW-FREQUENCY WAVES AND INSTABILITIES ON THE POSITIVE COLUMN IN A MAGNETIC FIELD. III. EXPERIMENTS ON ASYMMETRIC MODES. Duncan, A. J.; Forrest, J. R.; Crawford, F. W.; Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). Mar. 1969. Contract AT(04-3)-326. 30p. Dep. CFSTI.

In Parts I and II of this series, a theory was developed and studied numerically describing low-frequency wave propagation along a weakly ionized positive column in a magnetic field, B_z. Part III describes experimental verification of the analysis, based on observation of electron waves propagating along a low-pressure mercury-vapor discharge. For propagation in the direction of the axial electron drift, an azimuthal mode number $m \geq 1$, and rotation in the sense of the electron diamagnetic drift, these helical waves show a transition with increasing B_z from damping to spatial growth. Measurements of the wave-dispersion characteristics as a function of B_z show reasonable agreement with theory for the first two radial modes of $m = 1$. The behavior of the spectrum of self-excited waves, and the dependence of the steady axial electric field on B_z, are interpreted in terms of the linear perturbation theory. It is suggested that, for a low-pressure discharge, instability sets in first for high-order modes, localized near the outer radius, and spreads to low-order modes as B_z is increased. (auth)

32371 STRUCTURAL AND SPECTRAL INVESTIGATIONS OF A PLASMA JET IN A POWERFUL PULSED PLASMOTRON. Petrakiev, A. God. Sofii. Univ., Fiz. Fak., 61: 123-30(1966-67). (In Russian).

Structural peculiarities of various sectors of the pulsed plasma jet, flowing from the nozzle of a plexiglas plasmotron were investigated, using a time-resolution spectrograph. The radial profile of the temperature of the plasma jet and the speed and concentration of the charged particles, as functions of time of the discharge, were determined. (auth)

32372 SPECTRAL INVESTIGATION OF THE PLASMA JET. Petrakiev, A.; Kyurkchieva, D. God. Sofii. Univ., Fiz. Fak., 61: 139-50(1966-67). (In Russian).

The spatial distribution of the spectrum radiation of the plasma jet, obtained with the help of a plasmotron, was investigated. As cooling gases, nitrogen and argon at a pressure of 2 atm are used. Conclusions are made regarding the temperature of the plasma and the concentration of the charged particles in various sectors of the plasma, as well as the possibilities of utilizing the plasma jet for the purposes of spectral analysis. (auth)

32373 SPECTRAL INVESTIGATION OF A POWERFUL PULSED CAPILLARY DISCHARGE IN AN INERT GASES ATMOSPHERE. Petrakiev, A.; Nedyalkova, N. God. Sofii. Univ., Fiz. Fak., 61: 151-60(1966-67). (In Russian).

A powerful pulsed capillary discharge is investigated in an atmosphere of inert gases. The parameters of the discharge circle are as follows: capacitance—up to 520 μF; voltage—up to 3400 V. The development and structure of the discharge are investigated with the aid of high-speed photographs and the continuous unfolding of the glow of the discharge. The time-unfolded spectrum of the discharge is investigated. The behavior of individual spectral lines is studied as a function of the time. Appraisals are made of the temperature and the concentration of the charged particles in the plasma of the capillary discharge. (auth)

32374 OBSERVATIONS OF ENHANCED RESISTIVITY IN THE WAVE FRONT OF A LASER-PRODUCED PLASMA INTERACTING WITH A MAGNETIC FIELD. Schwirzke, F. (Naval Postgraduate School, Monterey, Calif.); Tuckfield, R. Phys. Rev. Lett., 22: 1284-7(June 16, 1969).

A laser-produced plasma was used in a new approach to the problem of investigating the mechanisms associated with the turbulent energy dissipation in a collisionless laboratory plasma. The measurements indicate that the two-stream instability enhances the resistivity in the wave front by more than two orders of magnitude and thus determines the width of the wave front to a value of about $d \approx 13c/\omega_{pe}$. (auth)

32375 ARC PHENOMENA AND GASDYNAMIC EFFECTS DUE TO INTERACTION OF SHOCK WAVES WITH MAGNETIC FIELDS. II. Klingenberg, H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 24a: 540-5(Apr. 1969).

In these experiments, continuing the work on interaction published in Z. Naturforsch., 23a: 1929(1968), the magnetic field, i.e., the retarding force, has been increased. This produces reflected shocks that leave the interaction region, but the steady state could not be achieved. (auth)

32376 CONTROL OF BEAM INSTABILITIES. Berezin, A. K.; Fainberg, Ya. B.; Bolotin, L. I.; (and others) (Inst. of Plasma Physics, Prague). pp 723-32 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Results of experimental studies on controlling beam instabilities by initial beam modulation and introducing an initial perturbation of nonfluctuating nature are presented. It is shown that hf high-power oscillations may be controlled by a very weak regular outer hf signal. The control of oscillation boils down to varying the spectra with respect to frequencies and phase velocities, degree of stochasticity, and nonlinearity of the excited oscillations. At a regular signal power of about 0.1 to 1W, the hf oscillations excited by beam-plasma interaction can be controlled with a power of 100 to 150 kW. Since the correlation method and the method of direct observation of the oscillation shape with subsequent Fourier analysis are the most efficient methods of studying the dynamics of instability development, the degree of stochasticity of the excited oscillations, and their frequency spectra, these particular methods were used in studying hf and lf oscillations in the plasma-beam discharge. The results of measuring the growth rates of hf fields for an interaction of nonmodulated and modulated electron beams with the plasma are presented. (auth)

32377 STUDY OF A NON-CYLINDRICAL Z-PINCH WITH CURRENTS EXCEEDING 1 MA. Agafonov, V. I.; Golub, G. V.; Golubchikov, L. G.; (and others) (Inst. of Atomic Energy, Moscow). pp 21-37 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Further investigation of noncylindrical compression in a z pinch was carried out in a device having a greater capacitor bank energy (130 kJ). Several ideas have been put forward regarding the nature of the processes occurring in a plasma focus and explaining the abnormal duration of the compressed state. The dynamics of the pinch was investigated by studying the characteristics of the soft x radiation. The plasma focus was photographed by means of streak photography in light derived from the soft x radiation. At the same time scintillation methods were used to determine (and compare the duration of) the total radiation over time and the radiation from a given part of the focus. Changes in electron temperature with time were followed by means of a two-channel x-ray monochromator. Further theoretical pinch effect calculations were carried out. Although the calculations of the one-dimensional (cylindrical) system were in satisfactory agreement with the observed picture, they revealed a substantial two-dimensional effect, particularly in the determination of the focus lifetime and characteristic transverse dimensions. Initial calculations were again performed allowing for the two-dimensional effect (the z axis being taken into account), again in a nonstationary formulation of the problem. The plasma conductivity was assumed to be infinitely large, so that the magnetic field enters only the boundary condition for the plasma gas pressure. The two-dimensional nature of the compression near the axis due to the loss of "mass per unit length" leads to a substantial increase in the parameters of the plasma in the compressed state. If one takes the position and shape of the current sheath as experimentally determined well before the moment of compression as initial conditions, then the calculations show considerable plasma motion in the axial direction (towards the cathode) with a powerful impact on the upper wall of the chamber causing deformation of the current sheath. At the moment when the plasma focus is formed, a burst of intense hard x-radiation is observed near the anode of the discharge chamber. It was found that the distribution of luminance over the anode surface repeats the peculiarities of the space of the central part of the anode. The total energy of the x-ray pulse, the spectral composition of the radiation, the intensity over time, the spatial distribution of the gamma flux, and the dependence of the latter on the anode material are investigated. Analysis of the results shows that the amount and nature of the radiation can be attributed to bombardment of the anode by an electron flux corresponding to 10 to 100% of the total current in the chamber. Apart from the quantitative dependence of the maximum yield on the capacitor band discharge conditions and the plasma focus parameters, the space and time characteristics of the soft x radiation were linked with the same characteristics of the neutron source. A multi-slit neutron collimator with suitable time resolution was used to detect motion along the axis. The position and radial displacement of the center of gravity of the source were recorded by means of indium and phosphorus detectors. (auth)

32378 STUDY OF THE PLASMA FOCUS OF A COAXIAL INJECTOR. Vasil'eva, R. P.; Pergament, M. I.; Yaroslavskii, A. I. (Inst. of Atomic Energy, Moscow). pp 39-50 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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The compressed plasma state that occurs towards the end of a coaxial accelerator under external current conditions was studied. The following were used: (1) a multipass interferometer with a laser illuminator and electron-optical recording, by means of which it is possible to determine the variation over time of the density distribution in the system; (2) a Thomson mass spectrograph with an ion-electron converter and an electron-optical multiframe camera, by means of which it is possible to record over time the plasma ion mass and energy distributions; the collimator of the spectrograph enables one to determine the region in which the particles undergoing analysis are formed; (3) a camera obscura with film absorbers for determining the spatial localization of the soft x radiation; (4) spectrum measurement instruments with short time resolution; and (5) magnetic probes. Analysis of the results showed that the "plasma focus" formed towards the end of the injector remains stable for 1.5 to 2 μs, which is many times greater than the time of flight of individual particles through this region. The temperature of the electrons in this region is substantially higher than in the interelectrode gap, while the density is 2 to 3 orders of magnitude greater than inside the coaxial system — reaching 10^{18} cm^{-3} under some conditions. From the density distribution pictures obtained during a single discharge it can be seen that, at moments of maximum compression, the half-width of the radial distribution is several millimeters. Judging by the topography of the magnetic fields, plasma energy leaks from this region along the lines of the zero field. From a comparison of the plasma parameters in the "focus" region with the energy distribution of the particles, conclusions are presented concerning the possible mechanism of plasma acceleration under conditions involving plasma compression. Experimental data relating to the ultra-high-speed particles produced in the interelectrode gap, the nature of which is not clear, are presented. (auth)

32379 EXPERIMENTS WITH IMPLODING PLASMA LINERS. Maisonnier, Ch.; Samuelli, M.; Linhart, J. G.; Gourlan, C. (EURATOM-CNEN, Rome). pp 77-86 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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In a discharge chamber of the type used by Filippov, experiments are performed on the interaction of a noncylindrical implosion of a deuterium or deuterium-xenon mixture plasma sheath, with a central core of pure deuterium injected by a fast valve. The influence of impurities is studied in detail; in very pure discharges, pulses of 6×10^{10} neutrons are systematically produced using a 33-kV, 80-kJ condenser bank. Careful measurements of the anisotropy of neutron emission clearly indicate that these neutrons are produced through a beam-target interaction, the energy of the beam being of the order of 5 to 10 keV. The differences with the results obtained by other authors are discussed. (auth)

32380 RELAXATION OF ION PRESSURE ANISOTROPY AND ENERGY TRANSFER BETWEEN IONS AND ELECTRONS IN HIGH-DENSITY PLASMAS. Bogen, P.; Lie, Y. T.; Rusbueldt, D.; Schlueter, J. (Kernforschungsanlage, Juelich, Ger.). pp 651-6 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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In pulsed high-density plasmas, containment times, magnetic field diffusion, thermal conduction, and radiation energy losses

are highly influenced by the evolution of the ion-pressure anisotropy and by the energy transfer between ions and electrons. To study these relaxation phenomena, experiments with a very fast theta pinch ($\tau/4 = 0.7\ \mu s$, $B_{max} = 75$ kG, no bias field) were carried out where the applied voltage and initial pressure could be varied over a large range. In a typical case (line density 7×10^{16} cm^{-1}) the time development of the plasma is as follows: at the end of the initial fast plasma implosion, a density of 1×10^{17} cm^{-3} is reached, the electron temperature T_e and axial ion temperature $T_{i||}$ (measured by the Doppler broadening of a CV line) are low (100 eV), whereas the radial ion temperature $T_{i\perp} \approx 900$ eV. During the adiabatic-compression phase, the anisotropy decreases, and both ion temperatures approach the value obtained from the neutron yield ($T_i = 470$ eV); T_e reaches about 340 eV. In agreement with the estimates given by the formulas of Spitzer and Kogan, an isotropic pressure and nearly equal T_e and T_i are reached during the adiabatic-compression phase when the line density is larger than 2×10^{17} cm^{-1}. At lower line densities, when the applied voltage is high, the ion-pressure distribution does not become isotropic during the observation time, and T_e remains considerably below T_i. In this case, T_e depends only weakly on the line density and applied voltage. A limitation of T_e has been reported by other authors and was believed to result from either thermal conduction or impurity radiation losses. These results cannot be explained by these effects alone. (auth)

32381 A THETA-PINCH EXPERIMENT OF A VERY-LOW-DENSITY PLASMA PREHEATED BY ION CYCLOTRON RESONANCE HEATING (QP-MACHINE). Miyahara, A.; Matsuura, K.; Horikoshi, G.; (and others) (Nagoya Univ., Japan). pp 619-28 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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A fully ionized steady-state plasma is prepared in a QP machine by pumping out the neutral particles in a high-current PIG discharge. In the plasma stream thus obtained, ion cyclotron waves are excited by a Stix-type induction coil at a frequency close to the gyrofrequency of the ion. The plasma is then heated by the cyclotron damping of the waves in the weaker beach field. Characteristic parameters of the plasma thus prepared for a theta-pinch experiment are: density varying from 1×10^{10} to $\sim 5 \times 10^{12}$ particles cm^{-3}; ion temperature 200 eV (without ion cyclotron resonance heating, 10 eV); electron temperature 10 eV; plasma column diameter 6 cm. A fast-rising magnetic field with a peak value of 71 kG and a half-period of 5 μs is applied to the plasma in the beach-field section of the machine, whose strength is variable from 1.5 to 5 kG. The single-turn coil used is 50 cm long and 10 cm in diameter. Observations are made by using an image-converter camera, spectrometers in visible and ultraviolet regions, a microwave interferometer, and diamagnetic loops. Ion-energy distribution is measured by an electrostatic energy analyzer located at end-on-view positions. The main interest of this experiment is focused on the behavior of the plasma of very-low-density regime of theta pinch. A simplified model of a pinch discharge gives a temperature rise of more than 1 keV, the trapping of the reverse field and the consequent electron-temperature rise of the plasma as well as its instabilities are investigated. (auth)

32382 VERY-HIGH-DENSITY THETA-PINCH. Hamm, J. J.; Knoeppel, H.; Kroegler, H.; Linhart, J. G.; Verbeek, R. (EURATOM-CNEN, Rome). pp 629-37 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

A series of experiments is described in which strong magnetic fields (100 to 400 kG) are used to generate theta pinches with very high ion densities ($n_i > 10^{17}$ cm^{-3}). The energy source is either a condenser bank (200 kJ, 15 kV) or an explosively driven energy generator with final magnetic fields of up to 400 kG. To minimize the axial plasma loss and to increase the heating towards the end of plasma compression, the reversed trapped-magnetic-field configuration is used. The rate of flux decay and the onset of instabilities were determined as a function of the most important parameters involved in the final experiment (dB/dt, density) and compared with numerical computations. Some unconventional techniques are applied in this experiment, for example, explosively driven magnetic flux compression to generate rapidly increasing high magnetic fields, and switching by means of explosives and conductors cut by detonating explosive strips in order to obtain the necessary dB/dt values between 10^{10} and 10^{11} Gs^{-1}. (auth)

32383 INTERACTION OF A PLASMA WITH THE CONTAINING HIGH-FREQUENCY TRAVELLING MAGNETIC FIELD. Levin, M. L.; Khodataev, K. V. (Radio-Technical Inst., Moscow). pp 461-8 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

A single high-frequency traveling field was used to produce a plasma column in quasi-stationary conditions in the "Delta" toroidal device. Its magnetohydrodynamic equilibrium and stability were theoretically and experimentally investigated. Provided the longitudinal drift current excited in the plasma by the traveling-wave high-frequency field does not disturb the column equilibrium, so that the column is established near the axis of the toroidal chamber, the energy lifetime and temperature of the electrons increase (electron temperature 40 eV at an electron concentration of 10^{14} cm^{-3}). Very good agreement was observed between calculation and experiment. In most cases the skin layer is approximately 0.3 to 0.6 cm. However, in certain conditions the radial amplitude distribution of the high-frequency field is nonmonotonic, with clearly pronounced maxima. The magnetic field amplitude at the surface of the column is 500 Oe, the generator frequency 2.5 Mc, and the length of the generator pulse 300 μs. The large diameter of the toroidal chamber is 10 cm, the small diameter 9 cm. (auth)

32384 DETERMINATION, BY PASSIVE MEANS, OF THE FUNDAMENTAL PARAMETERS OF A PLASMA FLOW INDUCED IN AN ANNULAR DUCT BY AN M. F. ELECTROMAGNETIC FIELD. Fournier, Gerard (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). Rech. Aerosp., 126: 61-6 (Sept.-Oct. 1968). (In French).

Simple diagnostic means, which still can be improved, allow the determination of the order of magnitude of the principal fundamental parameters of a plasma. The method can be applied to all ring induction setups where Ohm's Law reduces to the simple form $j_z = \sigma(E_z + u_x B_y)$ on the condition that the quantities j_z, E_z, and B_y are sufficiently out of phase with one another. The analysis of results produces the plasma conductivity when magnetic induction is nil, and of the flow velocity with the current density is nil. From the results for discrete moments, the order of magnitude of the electron temperature and density may be obtained. Development of studies on acceleration by progressive waves distinguishes the needs of applications of these fundamental studies. (BBB)

32385 STUDIES OF THE EARLY AFTERGLOW IN HELIUM AND ARGON PLASMAS. Gerardo, J. B.; Gusinow, M. A. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys., 40: 2533-44 (May 1969).

Spatially resolved measurements of parameters during the early afterglow of helium and argon plasmas are presented. The investigated plasmas were contained in a vessel with a wall temperature much less than the electron temperature at the center of the plasma. All measured parameters developed nonuniformly. In spite of the high thermal conductivity of the free electrons, a temperature gradient was supported; the electron temperature being highest in the center of the vessel. The mechanism by which these gradients were supported is discussed. Both the electron and neutral gas temperatures remained elevated at several thousand degrees for at least 200 μsec into the afterglow. Attention is also focused on the effect of spatially nonuniform plasma parameters on transport processes as well as the dependence of the net decay on the cold walls. (auth)

32386 INTERACTION OF AN ELECTRON BEAM WITH A FAST MAGNETOACOUSTIC WAVE. Ermakov, A. I.; Nazarov, N. I. (Kharkov Inst. of Physics and Tech.). pp 777-84 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The interaction of an electron beam with a fast magneto-acoustic wave excited in a plasma by external, spatially periodic currents of high frequency ($f = 1.03 \times 10^7$ c/s) was investigated. It is shown that when the condition $\omega - k_z v_0 + \omega_{He} = 0$ is fulfilled, there is an effective interaction between the electron beam and the wave that manifests itself as a sharp increase in the gas-kinetic pressure of the plasma and in x-ray emission and as a decrease in the high-energy electron current at the outlet of the system. It is shown that, as they acquire high perpendicular energies, about 30% of the electrons in the beam are held in the magnetic trap. The effective interaction between the electron beam and the wave lasts for about 7.5 μs and is followed by saturation of the dia-

magnetic signal; under certain circumstances strong uhf emission from the plasma is observed, its frequency coinciding with the plasma electron frequency. From investigations of this emission it may be assumed that it is caused by a nonlinear interaction of longitudinal Langmuir oscillations with the fast magnetoacoustic wave. (auth)

32387 EXCITATION OF OSCILLATIONS BETWEEN THE ION CYCLOTRON AND ELECTRON PLASMA FREQUENCY IN AN ION-BEAM GENERATED PLASMA. Dommasck, W. (Institut fuer Plasmaphysik, Garching, Ger.). pp 785-92 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

A helium ion beam propagating near the axis of a grounded metal cylinder with grounded grids at its ends penetrates neutral helium gas and generates a beam-plasma column. The beam-plasma is radially confined by a homogeneous magnetic field aligned parallel to the axis of the metal cylinder. The length of the plasma column, i.e., the distance between the two grids, is variable up to 100 cm and the diameter of the metal cylinder is 20 cm, whereas the beam diameter is about 2 cm. With neutral gas pressures in the range of about 10^{-4} torr, beam energies of about 10 keV, beam currents of a few milliamperes, and magnetic fields of some thousand gauss, oscillations with radial field amplitudes up to a few volts per centimeter in the megacycle range together with their lower "harmonics" are picked up by probes. The oscillation spectrum is more or less continuous, having apparent peaks at the "harmonic" frequencies. Oscillation amplitude measurements carried out along the plasma column with a movable probe, giving something like a standing wave envelope, and interference measurements between a fixed and a movable probe indicate phase velocities greater than the beam velocity. According to the dispersion diagram of a cold cylindrical beam-plasma these oscillations belong to a wave propagating between the fast cyclotron wave and the ω axis in the ω-k plane, i.e., to the electron plasma wave. Since this wave is stable in an infinitely long system, it is assumed that it be coupled to the unstable space charge wave by the axial boundary conditions of the finite beam plasma. This yields the desired instability and also a quantitative representation of the observed frequency spectrum. (auth)

32388 PLASMA-CYCLOTRON INTERACTION IN A SYMMETRICAL DOUBLE BEAM SYSTEM. Handel, D.; Mueller, G. (Institut fuer Plasmaphysik, Garching, Ger.). pp 793-800 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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An electron beam of density 2×10^7 to 6×10^8 cm^{-3} having an energy up to 1.5 keV and a 2×3 mm cross section is shot along the axis of a 160-cm long stainless-steel tube with a diameter of 17 cm, which is immersed in a homogeneous B field that is variable up to 1500 G. An end plate at floating potential reflects the beam. An instability at half the electron cyclotron frequency (1/2) ω_e is excited by the coupling of the space charge wave of the primary beam with the fundamental cyclotron wave of the counterstreaming reflected beam, and vice versa. Signals of (1/2) ω_e and harmonics of (1/2) ω_e up to the 30th order are observed in the frequency range 0.1 to 10 GHz as either x-band radiation received by a wave guide in the vacuum chamber or as hf-voltage fluctuations on the reflector plate or on coaxial probes located at the edge of the beam. These waves are observed only if the beam system is a multiple number of wavelengths long and the background gas pressure is less than 10^{-4} torr so that no secondary plasma is built up by beam-plasma interaction. Measurements of wavelength and phase velocity (approximately 10% less than the beam velocity) are made in a wide range of B field and beam energy. Collisionless damping of the waves is observed if the wavelength is less than approximately five times the Debye length of the beam plasma. The dependence of the damping on the beam density and on the beam temperature is investigated. The generation of the n $\omega_e/2$ harmonics is thus understood as a nonlinear effect rather than an interaction of the plasma wave with harmonic cyclotron waves. (auth)

32389 INVESTIGATION OF QUASI-STATIONARY ELECTRIC FIELDS AND PLASMA FLUCTUATIONS IN THE L-1 STELLARATOR. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; (and others) (Moscow Inst. of Physics). pp 529-42 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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The results of L-1 stellarator experiments relating to the quasi-stationary electric field and the fluctuations in a low-density collisionless plasma produced by external injection are presented. The experiments point out the important role played by the structure of the magnetic surfaces in plasma diffusion in the stellarator. The importance of the fine structure of the surfaces is established. The appearance of magnetic islands affects the macroscopic parameters of the plasma (containment time, potential). The plasma lifetime depends to a large extent on the rotational transform of the field lines. Investigation of the fluctuations shows that density and potential fluctuations with frequencies $f < 100$ kc occur in the plasma. The frequency spectrum and modes of these fluctuations are a function of the rotational transform of the field lines. Measurements of the radial plasma flux due to the fluctuations (based on the value of $\langle \tilde{n}\tilde{E} \rangle$) do not indicate any connection between the observed plasma losses and the fluctuations. The measurements show that, in the case of closed magnetic surfaces, the plasma acquires negative potential with respect to the chamber walls. The strength of the potential depends on the magnetic field intensity and on the rotational transform of the field lines. The observed correlation between plasma potential and plasma lifetime in the trap suggests that there is a particle escape mechanism associated with the absence of complete plasma equilibrium in the magnetic field of the stellarator. (auth)

32390 EXPERIMENTAL RESULTS ON THE GENERATION AND STRUCTURE OF COLLISIONLESS SHOCKWAVES. Hintz, E. (Kernforschungsanlage, Juelich, Ger.). pp 69-80 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Investigations on shock waves generated in z and θ pinches at low densities have previously shown that under certain conditions the structure of the wave front is determined by collective interactions. First experiments have been performed in a narrow parameter range. More experimental evidence on the dependence of the wave structure on shock parameters M_A, β_0, α, and θ is needed. Here $M_A^2 = U_0^2 4\pi n_0 m_i / B_0^2$; $\beta_0 = 8\pi n_0 k T_0 / B_0^2$; $\alpha = B_0^2/8\pi n_0 m_e c^2$; θ is the angle between B_0 and the wave front. B_0 is the initial magnetic field, n_0 the initial density, T_0 the initial temperature, m the particle mass, and U_0 the shock velocity. An investigation of the dependence of the structure of collision-free shock waves on β_0 (between 0.02 and 1) and M_A (between 1.3 and 10) with $\alpha \ll 1$ and $\theta \ll 1$ was one main objective of the experiments reported here. Another main purpose was to examine the conditions under which "steady-state" shock waves can be generated in a θ pinch, and to develop an experimental technique for the generation of such shock waves. The appearance of Rayleigh-Taylor instabilities in the plasma boundary is also discussed. (auth)

32391 INVESTIGATION OF ENERGY DISSIPATION IN COLLISIONLESS SHOCK WAVES. Chodura, R.; Keilhacker, M.; Kornherr, M.; Niedermeyer, H. (Institut fuer Plasmaphysik, Garching, Ger.). pp 81-92 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Strong magnetic compression waves are generated in a plasma with the electron density varying from 10^{12} to 5×10^{14} cm^{-3} by means of a fast theta-pinch discharge (dB/dt = 3.5×10^{10} G/s, coil length 60 cm, coil diameter 16 cm). The fast-rising magnetic field playing the part of the piston reaches 12 kG in 0.5 μs, and a quasi-stationary field can be superimposed. The working gas (H_2, D_2, He, Kr, Ar) is pre-ionized up to 20% ($n_e \approx 10^{12} - 2 \times 10^{13}$ cm^{-3}) by a pulse of strong ultraviolet radiation emitted by two z pinches placed at both ends of the discharge tube. This pre-ionization can be followed or, at pressures above 5 μ H_2 can be substituted, by a fast theta-pinch discharge which produces a highly ionized plasma of density 1 to 5×10^{14} cm^{-3}. In both cases, conditions for collisionless shock waves can be achieved. The width and structure of the shock waves were investigated by means of multiple magnetic probes. At electron densities $>10^{14}$ cm^{-3} and a plasma $\beta > 1$, shock waves with velocities between 2 and 4×10^7 cm/s are observed for both parallel and antiparallel initial fields. They show a well-defined shock front of width 0.5 to 1 cm, corresponding to 10 to 40 c/ω_p, and a clear separation between front and piston. By properly adjusting the initial values of electron

density and magnetic field, Alfvén–Mach numbers can be varied between 1 and 4. Their influence on the width of shock profiles and on heating rates is discussed. The energy spectrum of ions lost along the axis of the theta-pinch is measured by means of an electrostatic energy analyzer. Typical mean parallel energies are in the range of 200 to 500 eV. At densities between 10^{12} and 10^{13} cm^{-3} and a plasma with $\beta \ll 1$, nonstationary shock waves with velocities between 5×10^7 and 10^8 cm/s and a width of 5 to 10 c/ω_p are observed. The mean ion energies are a few keV. Experimental profiles of magnetic field are compared with calculations based on a two-fluid model containing a collisionless friction term, which roughly describes the action of a two-stream instability by limiting the electron velocity to a critical value. Thereby, this critical velocity is determined to be about $\frac{1}{4}$ to $\frac{1}{2}$ of the local rms velocity of electrons. (auth)

32392 EXPERIMENTS ON COLLISIONLESS SHOCK WAVES IN PLASMAS. **Yamanaka, C. (Osaka Univ.); Nakai, S.; Yamanaka, T.; Izawa, Y.; Kasuya, K.; Sakagami, Y.** pp 103-18 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

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The structure of collisionless shock fronts which is determined by the mechanisms of energy dissipation is one of the most interesting problems of recent plasma research. Three different approaches are used. The first method is to produce the shock waves in a pre-ionized collisionless magnetized plasma by a super-Alfvénic disturbance from a plasma gun. A strong linear pinch discharge of peak currents of 100 kA in rarefied gases was used to produce a plasma. The properties of the pre-ionized plasma were evaluated by the cutoff of the transmission of three different microwaves and the data from electric double probes. With a gas pressure of 10^{-3} torr, the degree of ionization was found to be about 90%. The initial electron temperature was up to 15 eV; the ion temperature estimated from the pinch velocity was also 15 eV. A conical gun was fired at a peak current of 200 kA in this collisionless plasma to drive the shock wave. By means of a magnetic probe a sharp front was observed, the thickness of which was much smaller than the mean free path. The Alfvén–Mach number was varied from 1 to 4. In a certain domain of the plasma parameter, defined by the three axes initial number density, the magnetic field and the atomic weight of the gas, the shock front had an oscillatory structure. This was markedly influenced by the Alfvén–Mach number. A Rogowski probe was used to detect the electron drift current flowing along the shock front across the magnetic field. When the electron drift velocity exceeded the thermal one, an intense soft x-ray burst was observed by a Be-foil CsI(Tl) scintillator. These results seem to confirm the existence of a collisionless turbulent dissipation at an Alfvén–Mach number of about 3. The second method consists of forming a standing shock wave with a transverse magnetic field in a fast collisionless cesium plasma flow produced by a plasma generator analogous to the ion rocket engine. The diminution of the pre-existent oscillation is very important. In the last method, the shock wave in a magnetized plasma is produced by irradiating the target with an intense laser beam. Various configurations of the magnetic field are used to study the dissipation processes and also to stimulate a solar flare phenomenon. (auth)

32393 OBLIQUE HYDROMAGNETIC SHOCK WAVES. **Robson, A. E.; Sheffield, J. (Univ. of Texas, Austin).** pp 119-28 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

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An experiment is described in which shock waves are propagated in a magnetized hydrogen plasma with Alfvén–Mach numbers up to $M_A = 5$ and at angles α to the magnetic field from 90 to 40°. The plasma of density $\sim 5 \times 10^{14}$ cm^{-3} and temperature ~ 1 eV is created in a pyrex chamber of 45-cm diameter and 93-cm length by means of an oscillatory z discharge. The initial magnetic field is 500 to 1000 G. A curved magnetic piston is driven into the plasma by exciting a rapidly rising θ current in a single-turn loop of short axial length arranged round the tube on its midplane. A curved shock front propagates ahead of the piston in the manner of a bow wave. Magnetic and electric probes are used to study the development and structure of the shock front. On the midplane, the front has the monotonic field jump typical of propagation perpendicular to the field, but for propagation at an angle to the field a radically different structure is seen. Ahead of the main jump in field and density there is a large-amplitude, circularly polarized oscillation which is identified as a high-frequency Alfvén ("whistler") wave propagating at the same speed as the shock. The results are compared with numerical computations of shock structure using hydromagnetic equations. To account for the observed structure, it is necessary to invoke collisionless effects. (auth)

32394 PROPERTIES OF A TOROIDAL SCREW PINCH SURROUNDED BY A CONSTANT-PITCH MAGNETIC FIELD. **Bobeldijk, C.; van Heijningen, R. J. J.; van der Laan, P. C. T.; Ornstein, L. Th. M.; Schuurman, W.; de Vries, R. F. (EURATOM-FOM, Jutphaas, Netherlands).** pp 287-97 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

In the screw pinch a toroidal plasma is produced by a fast-rising helical magnetic field. Experimentally this plasma is found to be in equilibrium, showing complete reproducibility during the 7 μs that the confining field is present (C. Bobeldijk et al., Plasma Physics 9: 13(1967)). The behavior of the screw pinch is strongly influenced by force-free currents flowing in the low-density plasma outside the central column. If the conductivity of this plasma is high enough and if near the wall field lines of constant pitch are applied, a constant pitch will result throughout the outside region. Experimentally, this constancy was observed. The plasma column is in equilibrium because the outward drift is counteracted by the compression of the B_θ field against metal shells surrounding the torus. Calculations on the equilibrium position show that a pinch surrounded by a constant-pitch magnetic field is more easily kept in equilibrium than a pinch surrounded by vacuum. Also, the stability is markedly improved by the presence of the constant-pitch region; a normal mode analysis shows that a $\beta = 0$ screw pinch is stable for all m and k. For high β, unstable modes with k numbers around the interchange value appear; the growth rates may be limited by a proper choice of the pitch and of the circumference of the torus. Apart from the arrangement mentioned above, a small device (R = 16 cm, r = 4 cm) is in operation. A combination of capacitor banks applies initially a fast-rising and then a low-frequency clamped field. This allows a study at higher temperatures and during longer confinement times. In a third experiment a torus of the same size as in the first assembly (R = 36 cm, r = 6 cm) and a 75-kJ clamped capacitor bank are used. The diagnostics include holographic plasma interferometry and miniaturized dielectric-filled waveguide probes. (auth)

32395 DIFFUSION AND RECOMBINATION IN A Q-DEVICE. **Hashmi, M.; van der Houven van Oordt, A. J.; Wegrowe, J.-G. (Institut fuer Plasmaphysik, Garching, Ger.).** pp 675-81 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

To determine the diffusion coefficient perpendicular to the magnetic field $\vec{B}$ in a Q device, the particle losses ($\|B$) at the hot end plates should be known. Assuming resistive diffusion, the "equilibrium" theory predicts for strong magnetic fields that the dominant loss process should be recombination at the hot end plates. Attempts were made to verify the "equilibrium" theory. For plasma densities $n \leq 10^{11}$ cm^{-3}, the particle losses were found to be much larger than expected from the theory. A $j_0 \sim n$ dependence instead of $j_0 \sim n^2$ was observed, j_0 being the incoming neutral flux. However, j_0 was determined indirectly in these experiments by just measuring the total ion flux φ. Moreover, no conclusive information was available regarding the nature of these additional losses, i.e., whether the particles are lost parallel or perpendicular to the magnetic field. Measurements are performed in a singly ionized barium plasma of a Q device (BARBARA) by varying the atomic flux, magnetic field, plate temperature, ion temperature, degree of ionization, and mode of operation (single- or double-ended). The central part of the hot end plate is "illuminated" by an atomic beam of barium. The plasma density distribution is measured by Langmuir probes, microwave cavity, and resonance fluorescence scattering (λ = 4554 Å) methods, whose reliability has been checked. The spectroscopic method is now also extended to the barium atoms (λ = 5535 Å), allowing one to perform the hitherto lacking direct measurement of j_0. Further, the total ion input flux and the outgoing flux normal to $\vec{B}$ are also measured. Moreover, analysis of the radial density profiles outside the "illuminated" region is also made as a function of B. These measurements give a possibility of a step-by-step determination of the particle losses perpendicular and parallel to $\vec{B}$ separately. (auth)

32396 PROPERTIES OF A PLASMA IN A COMBINED HIGH-CURRENT DISCHARGE. Kvartskhava, I. F.; Zukakishvili, G. G.; Gvaladze, Yu. S.; (and others) (Sukhumi Inst. of Physics and Tech., USSR). pp 237-54 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The results of experiments relating to the properties of the combined discharge that occurs when a θ pinch and a z pinch are produced simultaneously in the same space, and new data concerning θ pinches and z pinches separately, are considered. It is established that in this combined system the plasma is significantly more stable than in the individual pinches: the positive processes which are typical of the individual pinches and which promote plasma heating and containment are preserved and intensified, whereas the negative processes vanish or are substantially attenuated. For example, the hydromagnetic instabilities which occur in z pinches (m = 0 and m = 1 modes) or in θ pinches (cumulative ejection of plasma streams through the containing magnetic field) are not observed. Similarly, there is no repeated discharge along the chamber walls, which is typical of z pinches and which substantially limits heating of the compressed plasma since most of the discharge current thereby flows through the boundary region. In a combined pinch, the plasma maintains its stable state even when the longitudinal current flowing through it is several times in excess of the Kruskal-Shafranov limit. The observed effect of the initial stage in the development of the z-pinch discharge on the behavior of the plasma and on the distribution of the magnetic field in the combined pinch is discussed; pre-ionization of the gas and the superposition of an anti-parallel initial magnetic field improve the conditions for the formation of a skin layer and increase the efficiency of plasma compression and heating. Data are presented showing that there is a definite optimum relationship between the temperature of the electron component of the plasma in a combined pinch and the length of the period between the triggering of the θ pinch and the z pinch. Ideas of a thermodynamic nature are put forward and the conclusion drawn that, from the point of view of achieving a thermonuclear reaction under laboratory conditions, systems with $\beta \approx 1$ should offer significant advantages over systems with $\beta \ll 1$. (auth)

32397 POLYTRON: A TOROIDAL DISCHARGE WITH PULSED MAGNETIC CUSPS. Dangor, A. E.; Parkinson, G. J.; Dunnett, R. M.; Haines, M. G.; Latham, R. (Imperial Coll. of Science and Tech., London). pp 255-62 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

An experiment is described in which an axial current is produced in a toroidal plasma with many large superposed cusp magnetic fields and also a small axial magnetic field. The effects of preheating the discharge are given. It is shown that the presence of the magnetic fields modifies the discharge as follows: (1) $\omega\tau$ for the electrons is much greater than unity and the axial current is very much smaller than the axial current with no cusp fields; (2) a Hall current is produced by electrons drifting azimuthally in the cusp regions; this is verified by measurements of the axial magnetic field and of the total flux across the cross-sectional area; (3) the Larmor radius for the ions is greater than the separation of the cusps and the axial current is mainly composed of ions, thus motion of the plasma's center of mass is predicted. For the experimental conditions used the maximum ion velocity is limited by the periodic variation of the electric field rather than by collisions with trapped electrons. Spectroscopic measurements of the Doppler shift in an argon plasma made tangentially to the axis of the torus are given, together with measurements of the directed ion motion made with Faraday-cup-type probes. A computer study of a time-varying MHD model of the experiment was performed. Comparisons between computed and experimental results are given with predictions of the conditions necessary for a stable ion-current regime. (auth)

32398 STRUCTURE OF COLLISIONLESS SHOCK WAVES AND THE DISSIPATION OF STRONG ALTERNATING MAGNETIC FIELDS IN A PLASMA. Babykin, M. V.; Smolkin, G. E. (Moscow Inst. of Atomic Energy). pp 129-42 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Various collisionless plasma heating mechanisms are investigated by studying the structure of the front of straight shock waves as a function of the initial magnetic field and by studying the turbulence of the current layer in an experiment of the theta-pinch type. Collisionless shock waves are excited by trapezoidal pulses of a magnetic field having an amplitude of 1 to 1.5 kOe and a rise time of (3 to 5) $\times 10^{-9}$ s. The case where the pulsed field $\tilde{H}$ is parallel to the quasi-stationary field H_1 was investigated. The electron temperature was measured, and the nature of the propagation of probing magneto-acoustic perturbations in the plasma behind the shock wave front was studied for small and large Alfvén-Mach numbers M_A. The results indicate that in both cases there is collisionless heating of the electrons, and for large M_A, a strong irreversible process apparently caused by the appearance of energetic ions in the plasma was also observed. In an experiment with anti-parallel $\tilde{H}$ and H_1 fields, the experimental conditions exclude the formation of a shock wave. A plasma in the form of a hollow cylinder was used here. The external magnetic field H, with an amplitude of 3 kOe and a frequency f = 0.84 Mc, was produced by a broad winding. The formation of a cylindrical current layer in the region of zero magnetic field was observed. For plasma densities below 4×10^{13} cm^{-3}, there was effective heating of the plasma electrons, accompanied by intense noise emission at wavelength $\lambda = 3$ cm and a sharp decline in the lifetime of the trapped magnetic field. This indicates turbulent heating of the plasma in the current layer. (auth)

32399 BEHAVIOUR OF OHMICALLY HEATED PLASMA IN A HELIOTRON MAGNETIC FIELD. Uo, Koji; Itatani, Ryohei; Mohri, Akihiro; Oshiyama, Hiroshi; Ariga, Seiichi; Uede, Taisei (Kyoto Univ.). pp 217-23 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The behavior of a plasma produced by ohmic heating in a corrugated toroidal magnetic field with circular cusp trains near the wall — the heliotron field — is studied experimentally. Rogowski-coil and directional-probe measurements show that the current column is well confined inside the separatrix without contacting the wall of the vacuum vessel and seems to be stable with respect to Kruskal instabilities as could be expected. The effect of the vertical magnetic field B_v on the plasma equilibrium is examined. The cross-section area, where the equipotential surfaces of the static electric field across the plasma column are closed, becomes maximum for optimum B_v and fills up the region inside the separatrix. When B_v is not optimum the area is small and some of the equipotential surfaces inside the separatrix are not closed. Experimentally observed optimum values of B_v are by more than a factor of 2 smaller than the theoretically calculated values; changing the heliotron field to the Tokamak-type field makes little difference, although the plasma parameters remain almost the same in both cases. Periodically intensified B_v in space corresponding to the period of the corrugated field remarkably improves the maximum current. Anomalous plasma loss through the ring cusp is observed. It results from the cusp split due to strong pulsive azimuthal current flowing through the cusp. This pulsive current is the azimuthal component of a spiral plasma current string rotating around the minor axis. The period of the rotation or of the pulsive current increases with increasing magnetic field intensity and plasma density, and finally the rotation ceases. When this current flows through the cusp, the cusp splits into two parts and the magnetic lines of force, formerly confined inside the separatrix, move outside and cross the wall resulting in an anomalous plasma loss. It seems that, under the present experimental conditions, the plasma in the heliotron field hardly forms the necessary plasma density profile required for stability against interchange, and the plasma becomes unstable for interchange of m = 1. The rotation is due to the radial electric field. (auth)

32400 LONGITUDINAL PLASMA STREAMS IN HEAVY-CURRENT ELECTRIC ARCS. Bron, O. B.; Sushkov, L. K. Elektrotekhnika, No. 9, 33-6(1967). (In Russian).

Longitudinal plasma streams with small arc currents were investigated by H. Maecker (Z. Physik, 141: 198-216(1955)) and other researchers. This article reports the results of an experimental investigation of plasma streams in short-time (0.02 to 0.08 sec) arcs between copper, brass, steel, and carbon electrodes spaced by 20 to 70 mm, with dc currents 200 to 15,000 A. Sketches of electrodes and arc shapes are shown, as well as arc photographs. It was found that: (1) plasma streams arise with any artificial restriction of arc diameter; the streams are perpendicular to their source surface; (2) because of the greater part played by thermal processes, the plasma-stream orientation is less sharply defined at heavier currents; (3) the plasma-stream

length increases rapidly with currents up to 5 kA, then increases slowly, and then remains constant; the plasma-stream diameter steadily increases with current; (4) the front of a plasma stream first advances rapidly and then slows down; (5) plasma streams emanating from electrodes cause their wear by carrying away metal vapor; and (6) plasma streams have a higher temperature than the arc playing between them; these streams cause greater insulating-plate burnout than the arc proper. (ATD)

32401 ANOMALOUS SKIN EFFECT IN A GASEOUS PLASMA. Kofoid, M. J. (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 12: 1290-3(June 1969).

Experimental data are presented for the skin effect in a plasma in which the electron thermal motions are sufficient to increase the field penetration. The results are consistent with the Weibel criteria for the existence of anomalous penetration and with the theoretical anomalous penetration depth. (auth)

32402 EXPERIMENTAL STUDY OF THE STRUCTURE OF PLASMA SHOCK WAVES IN A FAST θ-PINCH. Stamper, John Andrew. College Park, Md., Univ. of Maryland, 1968. 85p.

Thesis.

The density, temperature, and magnetic field structures of plasma shock fronts have been observed by means of scattered light, a magnetic probe, and emission spectroscopy. The shocks and initial hydrogen plasma were generated by capacitor discharges through a single-turn coil placed around a cylindrical quartz tube containing hydrogen. The electron velocity distributions were obtained by analyzing the light scattered at 90° to the incident beam from a Q-switched ruby laser. The observed temperature structure was compared with that calculated from observed particle and current density by assuming local resistive dissipation due to binary electron–ion collisions. Agreement was good in two cases, but, in a case characterized by lower initial $\omega_{ce}\tau(0.6)$, the velocity distribution developed enhanced wings and enhanced heating occurred. The effects indicate a diffusion of high-energy electrons from the hot, downstream region. The electron distribution function was of the same form in the r–z and θ–z directions. Ion temperatures, obtained from Doppler broadening of a carbon line, are consistent with compressional heating and thermal conduction across field lines. (Disser. Abstr.)

32403 MEASUREMENT OF THE TIME BEHAVIOR OF TEMPERATURE IN A PLASMA–BEAM DISCHARGE. Lifshits, E. F.; Kovpik, O. F.; Kornilov, E. A. Opt. Spectrosc. (USSR) (Engl. Transl.), 25: 373-7(Nov. 1968).

Translated from Opt. Spektrosk., 25: 664-73(Nov. 1968).

An experimental investigation was made of the time behavior of the electron temperature in a plasma formed by plasma–beam interaction. The measurements were made by comparing the intensities of a given line under different discharge conditions. The advantages of this method as compared with measurement of the relative intensities of a pair of lines are pointed out. This method enables one to make reliable T_e measurements at higher densities. The two methods are compared; for densities up to 10^{12} cm^{-3}, the temperature values obtained are identical. The radial temperature distribution is determined using the Abel integral transform. It is shown that by using temperature values obtained from line pairs, the plasma density can be found by yet another independent method. The measurements were made in a plasma-beam discharge in a magnetic field having the "magnetic mirror" shape; the electron beam current was 8 to 10 A and the energy was 10 keV. (auth)

32404 ELECTRON BEAM FROM A MAGNETOPLASMADYNAMIC ARC. Ducati, Adriano C. (Plasmadyne, Santa Ana, Calif.); Jahn, Robert G. Phys. Fluids, 12: 1177-81(June 1969).

A long, tenuous, but well-collimated beam of luminosity is observed to emerge from the plume of a magnetoplasmadynamic arc operated in a fiberglass vacuum tank. Examination of the beam trajectory in the magnetic field of the earth, and in other externally imposed fields indicates that the beam consists of a stream of 100-V electrons emitted from the core of the arc, which excite background gas particles to luminosity along their path to the tank wall. Although this beam carries a negligible portion of the arc current, the particle energy corresponds to some two-thirds of the arc voltage, and the beam is capable of damaging material surfaces which it encounters. Formation and emission of such a well-collimated stream of electrons of this energy seems incompatible with present concepts of magnetoplasmadynamic arc structure, and may have implications for space thruster applications. (auth)

32405 PRECURSORS AHEAD OF SHOCK WAVES. I. ELECTRON DIFFUSION. Weymann, Helmut D. (Univ. of Rochester, N. Y.). Phys. Fluids, 12: 1193-9(June 1969).

Experimental investigations of precursors ahead of pressure-driven shock waves in argon lead to the conclusion that, for the existing conditions, electron diffusion is the dominant cause of the precursors. A theoretical analysis of the electron temperature and density is presented. (auth)

32406 PRECURSORS AHEAD OF SHOCK WAVES. II. PHOTOIONIZATION. Holmes, Lawrence B.; Weymann, Helmut D. (Univ. of Rochester, N. Y.). Phys. Fluids, 12: 1200-10 (June 1969).

Experimental investigations of precursors ahead of pressure driven shock waves in argon show that, for the existing conditions, photoionization is the dominant cause for the precursor. A theoretical analysis of the electron temperature and density is presented. (auth)

32407 PRECURSOR VACUUM ULTRAVIOLET RADIATION IN A T-TYPE SHOCK TUBE. Greig, J. R.; Palumbo, G. (Univ. of Maryland, College Park). Phys. Fluids, 12: 1211-15(June 1969).

Using a small-bore (1.5 cm) T tube, measurements have been made of the flux of vacuum ultraviolet radiation along the axis of the expansion tube. These measurements coupled with measurements of the precursor emission in the line He I 5876 Å indicate that ionizing radiation does not contribute significantly to precursor ionization and excitation. (auth)

32408 PRECURSOR OBSERVATIONS IN ELECTRICAL SHOCK TUBES. Russell, Geoffrey (Univ. of Oklahoma, Norman). Phys. Fluids, 12: 1216-17(June 1969).

An experiment that demonstrates the separation of the photon-induced precursor and electron-produced wave from an electrically driven shock tube is discussed. The velocity of the fluid-dynamical electron wave is of the order of 10^9 cm/sec, and a plot of its velocity as a function of driven voltage is given. (auth)

32409 SHOCK AND CURRENT-SHEET SEPARATION IN MAGNETIC SHOCK TUBES. Sorrell, F. Y. (Univ. of Colorado, Boulder). Phys. Fluids, 12: 1218-27(June 1969).

The problem of separation of a shock wave from the current driving it, is experimentally investigated over a wide range of Mach numbers in a single gas. In order to do this, a parallel-plate shock tube was developed that produces repeatable shocks in hydrogen from Mach 20 to 180 at initial pressures from 75 to 460μ Hg. In the present work, no preheating or external magnetic fields were used and the shock is completely collision dominated. The shock-wave and current-sheet trajectories were determined by piezoelectric pressure probes and magnetic pickup loops, respectively, and separation of the shock wave from the driving current was measured directly at speeds above 8.0 cm/μsec and initial pressures above 250μ Hg. Experiments were performed at speeds up to 22 cm/μsec at lower pressures, but separation was not observed at these conditions. The electron temperature behind the shock and within the current layer was determined by using the ratio of continuum intensities across the Balmer series limit, and these temperature measurements were used in connection with the other data to explain most of the observed results. The data are also used to examine the applicability of the skin-depth model and shock-formation theory in predicting separation in magnetic shock tubes. (auth)

32410 OBSERVATION OF SURFACE MODES EXCITED BY AN ELECTRON BEAM IN A PLASMA. Boehmer, H.; Raether, M. (Univ. of Illinois, Urbana). Phys. Lett., 29A: 302-3(June 2, 1969).

Unstable oscillations at frequencies below the plasma frequency are observed at the plasma boundary during the interaction of an electron beam with a plasma. They are interpreted as the eigenmodes of the inhomogeneous plasma boundary, driven into instability by the beam. (auth)

32411 EFFECT OF OPTICAL ORIENTATION OF ^{4}He ATOMS IN THE 2^3S_1 STATE ON THE ELECTRON DENSITY AND RADIATION OF HELIUM ATOMS IN A PLASMA. Sevast'yanov, B. N.; Zhitnikov, R. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 56: 1508-18(May 1969). (In Russian).

The effect of optical orientation of ^{4}He atoms in the 2^3S_1 state on the radiation of ortho- or parahelium atoms in a gas-discharge absorbing cell is studied under various experimental conditions. It is found that, on destruction of orientation of the helium atoms in the 2^3S_1 state, the electron density in the plasma of the gas discharge cell increases. Some suggestions concerning the nature of the phenomena observed are presented. (auth)

Kinetics (Theoretical)

32412 (NP-17885(Pt.1)) INTRODUCTION TO THE STATISTICAL THEORY OF NONLINEAR PARTICLE-WAVE INTERAC-

TIONS IN PLASMA. PART I. Preprint No. 117. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 73p. (In Russian). Dep.

The theoretical aspects and general theory of statistical interactions of charged particles and waves in plasma and the development of the basic equations for a weakly turbulent plasma are discussed. (R.V.J.)

32413 (NP-17885(Pt.2)) INTRODUCTION TO STATISTICAL THEORY OF NONLINEAR PARTICLE-WAVE INTERACTIONS IN PLASMA. PART II. Preprint No. 117. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 154p. (In Russian). Dep.

The practical applications of the equations and certain concrete problems in the physics of weakly turbulent plasma are discussed. The interactions of radiation with turbulent plasma and the resolution of nonlinear problems of current instability of isothermal plasmas are also discussed. (R.V.J.)

32414 (SU-IPR-266) INVESTIGATION OF SURFACE WAVES AND THEIR AMPLIFICATION BY BEAM/PLASMA INTERACTION. Ristic, V. M. (Stanford Univ., Calif. Inst. for Plasma Research). Dec. 1968. Contracts AT(04-3)-326; DA-28-043-AMC-02041(E). 120p. (ECOM-2041-16). Dep. CFSTI.

Propagation of surface waves on a plasma column and their interaction with an electron beam penetrating the plasma were investigated. The dispersion relation for plasma surface waves is first examined for several geometries in which the column is surrounded by one or two dielectric layers, with and without a surrounding conducting waveguide. For a practical geometry, and for the case of an electron beam filling the plasma, the dispersion relation for the combined beam/plasma system is analyzed according to general criteria for determining instability and wave types. This analysis is carried out for both axisymmetric (m = 0), and asymmetric (m = 1) modes, and for a number of different beam velocities. It is shown that the system may be either convectively or absolutely unstable, depending on the beam parameters. These findings are compared with the predictions of simple coupled-mode theory, and it is demonstrated that misleading conclusions can be drawn if such theory is applied to beam/plasma interactions. The dispersion relation for the situation where the beam only partially fills the plasma is briefly examined. In this case, interaction may not only occur with the plasma surface wave but also with plasma oscillations (beam/body wave interaction). The results indicate that unless the beam nearly fills the plasma the beam/surface wave interaction will be weak, and the beam/body wave interaction will predominate. Preliminary experiments are described in which an attempt was made to measure growth in the surface wave mode, and to relate the measurements to the theory. It is concluded that the prospects for a practical amplifier employing beam/surface wave interaction, competitive with existing devices, are poor. (auth)

32415 (SU-IPR-275) INTERACTION OF A CYLINDRICAL BEAM WITH A PLASMA. PART I. THEORY. Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). Jan. 1969. Contract AT(04-3)-326. 55p. Dep. CFSTI.

A linear analysis is given of the interaction of a homogeneous, monoenergetic cylindrical electron beam, of radius a, with a homogeneous, cold plasma for two cases: (A) the plasma is unbounded, (B) the plasma is bounded by a conductor at radius b (>a). The quasi-static approximation is compared with an exact treatment, and conditions for the validity of the former are stated. A stability analysis according to the method of Derfler and Briggs is carried out in terms of the mapping of ω into the complex k plane. It is shown that the system is always absolutely unstable and the dependence of the stability analysis on the system parameters is discussed. The absolute instability is, however, always sufficiently weak that in practice the stabilizing effect of collisions is sufficient to quench it, leaving a convective instability. The properties of the amplifying waves resulting from collisional stabilization are discussed for parameter values appropriate to the experimental conditions described in Part II. (auth)

32416 MAGNETIZED POSITIVE COLUMN IN TURBULENCE. Matsumoto, Michio (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 26: 1280-5(May 1969).

Positive columns in magnetic fields B which are much stronger than the critical field B_c for helical instability are studied theoretically. Radial density distributions $n_0(r)$ of charged particles are expressed by the confluent hypergeometric function when the time average $\langle n_1 E_1 \rangle$ is proportional to $rn_0(r)$, where n_1 and E_1 are the fluctuating densities and electric fields. Relative magnitudes of the discharge electric field E_{0z} to that at B = 0 are estimated through the degree of $\langle n_1 E_1 \rangle$. From constant fields E_{0z} regardless of an increase of B, it is derived that $|\langle n, E_1 \rangle|$ almost linearly depends on B and loss flows of the plasma across B become constant. (auth)

32417 HIGHER HARMONICS GENERATION IN WEAKLY IONIZED PLASMAS IN TIME-VARYING CROSSED FIELDS. Stiller, Wolfgang; Vojta, Guenter (Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch., 24a: 545-55(Apr. 1969).

The linearized Boltzmann equation of kinetic theory for the electrons of a weakly ionized plasma under the action of an alternating electric field $E = \cos \omega t \{E_x, E_y, E_z\}$ and a circularly polarized magnetic field $B^R = B \{\cos \omega_B t, \sin \omega_B t, 0\}$ is solved. The direction-dependent part $f^1(r,v,t)$ of the distribution function contains especially higher harmonics with frequencies $2\omega_B$, $\omega \pm \omega_B$, $\omega \pm 2\omega_B$. These overtone frequencies are generated—unlike the higher harmonics obtained by Margenau and Hartman—by a cross-drift mechanism and are present even if the isotropic part f^0 of the electron distribution function is assumed to be time-independent. The physical meaning of the various contributions to the distribution function f^1 is discussed in detail. (auth)

32418 GENERALIZED ELECTRON CYCLOTRON RESONANCE IN WEAKLY IONIZED TIME-VARYING MAGNETOPLASMAS. Stiller, Wolfgang; Vojta, Guenter (Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch., 24a: 555-9(Apr. 1969).

The electron distribution function is calculated explicitly for a weakly ionized plasma under the action of an alternating electric field $E = \{0, 0, E_{0z} \cos \omega t\}$ and a circularly polarized magnetic field $B^R = B_c \{\cos \omega_B t, \sin \omega_B t, 0\}$ rotating perpendicular to the ac field. Furthermore, a constant magnetic field $B_0 = \{0, 0, B_0\}$ is taken into account. The isotropic part f^0 of the electron distribution function which contains, in special cases, well-known standard distributions (distributions of Druyvensteyn, Davydov, Margenau, Allis, Fain, Gurevich) shows a resonance behavior if the frequencies ω, $\omega_c = (q/m) B_c$, $\omega_0 = (q/m) B_0$, and ω_B satisfy the relation $\omega = \sqrt{\omega_\xi^2 + (\omega_0 + \omega_B)^2}$. This can be understood as a generalized cyclotron resonance phenomenon. (auth)

32419 FORMALISM FOR STUDY OF A PLASMA IN THE NEIGHBORHOOD OF STEADY-STATE EQUILIBRIUM. Rebut, Paul Henri; Samain, Andre (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. B, 268: 783-5(Mar. 17, 1969). (In French).

A collisionless plasma in steady-state equilibrium in an oscillating electromagnetic field is considered. A formalism is described for calculating the linear relation between the electromagnetic perturbation and the charges and currents induced in the plasma. This formalism can be used to specify the modes of a plasma. (tr-auth)

32420 NONLINEAR THEORY OF BEAM-PLASMA INTERACTIONS. I. Leven, Ronald (Univ., Greifswald, Ger.). Beitr. Plasmaphys., 9: 29-44(1969). (In German).

The beam-plasma interaction is theoretically investigated on the basis of the nonlinear Vlasov equation. The case of amplifying longitudinal waves is described by a nonlinear approximation including "quasi-linear" and mode-coupling terms. By evaluating the electric field vector E(x,t) and the distribution functions $f_a(x,v,t)$ for the beam and plasma electrons in Fourier series, and approximating the nonoscillating parts of f_a by the first terms in an expansion using Hermite polynomials in velocity space, ordinary differential equations for the complex wave number k, the mean and thermal velocities, and the quasi moments b_{a_i} are obtained, which can be solved numerically, if terms with E_n^m for which m + n > 3 are neglected. The numerical results will be given later. (auth)

32421 DIELECTRIC CONSTANT OF A WEAKLY TURBULENT PLASMA. Berthomieu, G. (Institut d'Astrophysique, Paris). Phys. Lett., 29A: 242-3(May 19, 1969).

The eigenfunctions of linerized Vlasov equation (Van Kampen modes) are used to calculate the dielectric constant of a weekly turbulent plasma and the correction to Langmuir frequency due to turbulence as a function of the energy of the excited waves. (auth)

32422 SCATTERING OF PHOTONS BY PLASMAS. Rae, J. (Univ. of Glasgow). J. Phys., A (London), 2: 323-9(May 1969).

Thermodynamic Green function techniques are applied to the Compton scatter of photons by electrons in a hot plasma. An expression is obtained for the scattering rate, including relativistic effects but neglecting coupling to ions or other electrons; this restricts the formula to high-energy photons and nonzero scattering angles. The method of calculating explicit cross sections is illustrated by deducing the known result for Doppler-broadened scattering from free electrons in the nonrelativistic case. (auth) (UK)

32423 RELATION OF IONIZATION EQUILIBRIUM OF NON-THERMAL HYDROGEN PLASMA. Suckewer, S. (Inst. of Nuclear Research, Swierk, Poland). Phys. Lett., 29A: 240-1 (May 19, 1969).

A formula is given for calculation of the density ratios of hydrogen ions and atoms for a nonthermal plasma. The obtained diagrams are compared with the calculations of Bates et al. (auth)

32424 DEPENDENCE OF ION CYCLOTRON INSTABILITIES ON PARTICLE DISTRIBUTION FUNCTIONS IN THE ALICE EXPERIMENT. Damm, C. C.; Foote, J. H.; Futch, A. H. Jr.; (and others) (Univ. of California, Livermore). pp 253-66 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Plasma formed in an open-ended system by energetic particle injection is subject to instability because of the departure of the trapped-ion distribution function from the Maxwellian form. The objective of the Alice neutral injection experiment is to study the stabilizing effects of changes in the ion and electron distribution functions. A series of perturbations and alterations of the distribution functions is in progress. The results of the first of these perturbations are reported here. The plasma is contained in a quadrupole magnetic well generated by a coil in the shape of a baseball seam. Protons are trapped by Lorentz-force ionization of excited atoms in the injected beam, forming a steady-state plasma. At densities above $10^8/cm^3$, intermittent oscillations were observed, both at the ion gyrofrequency, ω_{ci}, and at higher frequencies. At these densities, observed oscillations are accompanied by anomalous loss of particles; bursts of electrons and ions were detected emerging through the mirror regions. At a density of $5 \times 10^8/cm^3$, $\omega_{pi}^2/\omega_{ci}^2$ is of order 0.5, where ω_{pi} is the ion plasma frequency. At this density the mean anomalous loss and charge-exchange loss times (~0.5 s) are comparable. Energy modulation of the injected beam by 20% results in a broadening of the energy spectrum of the trapped protons. As a consequence, an increase of about 25% in the threshold density for onset of the plasma oscillations was observed in this case. A more pronounced effect on the high-frequency activity was observed by alteration of the electron distribution. Application of a few watts of microwave radiation at a frequency corresponding to the electron gyrofrequency in a magnetic field near the region of peak ion density results in a decrease in the activity at ω_{ci} and an increase in trapped-proton density. However, when the microwave frequency is adjusted to correspond to a different region of the plasma, enhanced activity at the ion gyrofrequency is observed together with increased proton losses. (auth)

32425 HIGH-TEMPERATURE PLASMA WITH A COLD GAS BLANKET IN A TOROIDAL MAGNETIC FIELD. Berghahn, H. H.; Feneberg, W.; Karger, F.; Venus, G. (Institut fuer Plasmaphysik, Garching, Ger.). pp 113-24 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The maximum attainable plasma temperature in a linear high-current high-density arc with a longitudinal magnetic field is limited by the end losses. In a plasma torus, end losses do not occur. There is, however, the question of what influence the curvature has on the plasma, i.e., whether an arc in a toroidal magnetic field can burn in a stable manner in the center of the vessel or whether it is displaced to the wall, and how large the energy losses and axial temperature are compared with those of an arc in a linear magnetic field. To solve this problem using the classical heat conduction equations for ions and electrons, the temperature profile resulting from ohmic heating was calculated as a function of time. Since the thermal conductivity parallel to the magnetic field is high, the temperature in the hot regions is constant on the magnetic surfaces. The magnetic surfaces are formed by superposition of the magnetic field produced by the discharge current on the high longitudinal field. The rotational transform thus obtained ensures that the plasma is in equilibrium. The position of the plasma is given by the wall isotherms. As a preliminary study of the conditions in the whole torus, two independent experiments with torus sectors for investigating discharges in hydrogen and helium were conducted. The experimental data are as follows: torus diameter 1 m (30° sector) and 0.7 m (180° sector), plasma diameter approximately 3 cm, plasma density 10^{15} to 10^{16} cm^{-3}, discharge current 3 kA, discharge time 1 ms and 20 ms, respectively, external magnetic field 50 kG and 25 kG, respectively. The results of the experiments are as follows: (a) the hot regions of the plasma (axial temperatures up to about 100,000°K) are not forced to the outer wall, as widely feared, but rather tend to be slightly displaced to the inner wall; (b) using streak pictures in the light of He II (λ = Å) it is found that, with a suitable choice of parameters, the arc is stable, and (c) losses in the toroidal discharge are not much higher than in the linear case, as measurements of the longitudinal electric field strength and axial temperature show. The results of the calculations and the two experiments raise hopes that a stationary high-temperature plasma free of MHD instabilities can be obtained by neutral gas confinement in a closed torus with a superposed magnetic field. (auth)

32426 NON-ADIABATIC BEHAVIOUR OF PARTICLES IN INHOMOGENEOUS MAGNETIC FIELDS. Hastie, R. J.; Hobbs, G. D.; Taylor, J. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 389-402 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Results of a numerical study of charged particle orbits in linear multipole fields are presented. This study included, in particular, the breakdown of adiabatic behavior in regions of magnetic field. The breakdown, which is confined to comparatively short lengths of an otherwise adiabatic orbit in the vicinity of the field minima, results in abrupt step-like changes in the particle's magnetic moment μ. The circumstances in which this occurs were analyzed and a theory is presented which predicts, and is in agreement with, the observed dependence on the various parameters of the particle trajectory (energy, pitch, phase for example). (auth)

32427 PROPERTIES OF TOROIDAL PLASMAS WITH FINITE β. Adam, J.-C.; Mercier, E. (EURATOM-CEA, Fontenay-aux-Roses, France). pp 199-216 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In French).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol. 1); CONF-680805-(Vol. 1).

There are particular values $(\iota/2\pi)_0$ of the rotational transform on the magnetic axis in the vicinity of which the plasma is strongly perturbed. If the plasma has a plane magnetic axis defined by its curvature, $1/R(s) = \Sigma a_k \exp(i2k\pi s/L)$ a value of $(\iota/2\pi)_0 = k$ corresponds to each Fourier coefficient $a_k \neq 0$. There are two possible methods for studying these deformations and their effect on plasma stability: expansion in the vicinity of a magnetic axis; and the helicoidal approximation, which is applied particularly to the type of configuration whose rotational transform is due to the longitudinal current. This approximation reduces the problem to one of solving equations for a helicoidal plasma and simplifies analysis. A general study was made of the equilibria predicted in devices of the Tokomak and Harmonica types. It is shown how the various equilibrium characteristics (displacement of the magnetic axis, mean magnetic well-V″, and shear) vary as a function of parameters such as $\langle\iota/2\pi\rangle$ and $\beta = \langle 2p/B^2\rangle$ and those parameters characterizing the current and pressure distributions. The above quantities increase substantially as $(\iota/2\pi)_0$ is approached, until the simple-topology (one magnetic axis) equilibrium breaks down. Models describing the behavior of a plasma with several magnetic axes are studied and tend to prove that, when one passes the point where $(\iota/2\pi)_0 = k$, there results either strong turbulence of the plasma or states involving several magnetic axes. The equilibrium can be studied experimentally by measuring the flux passing through a loop formed by two diametrically opposed conductors wound several times around the torus. The plasma displacement and formulas giving this flux as a function of the plasma parameters are established and compared with the experimental results. The MHD stability is studied with the localized criterion. The high $V'' < 0$ and the strong shear calculated near $(\iota/2\pi)_0$ favour non-MHD instability. (auth)

32428 EFFECT OF RADIATION UPON THE POST-SHOCK STATE. Koch, Paul; Gross, Robert A. (Columbia Univ., New York). Phys. Fluids, 12: 1182-92(June 1969).

The effect of radiation upon the state of the gas behind a strong shock wave is studied. The equations of radiation gas dynamics are used, and it is shown that the two characteristic times, τ the time for radiative cooling, and λ/c, the mean time of photon flight, determine whether a strong shock wave is optically thin. The steady-state shock jump conditions for hydrogen are determined for plasmas which are optically thin, and they are compared with the Saha equilibrium solutions. The temperature decay, plasma velocity, and density behind strong shock waves are determined for the case of an optically thin bremsstrahlung radiating plasma.

The time-dependent equations of the motion of a fluid int .cting with radiation are examined and the radiative terms in ..ese equations are presented as part of a general solution of the time-dependent radiative transfer equation. (auth)

32429 PENETRATION OF A HIGH-FREQUENCY FIELD IN A LOW-PRESSURE PLASMA. Kofoid, M. J.; Cleva, H. V. (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 12: 1279-89(June 1969).

Comparisons between calculated and directly measured values of radial penetration of axially directed magnetic fields in cylindrical plasmas have been effected. Using elementary theory, the curve of field intensity vs radius was calculated which matched the measured intensity. The level of conductivity demanded by theory was then compared with that deduced directly from the measured n_e and T_e. When the experimental conditions corresponded closely to those assumed in the elementary theory development, the conductivities agreed well. The investigation was made in 5-cm-diam noble gas discharges at 5 to 500 μ with steady 500 kc/sec fields of 50 to 80 G at the plasma surface. T_e and n_e were measured vs radius; the ranges of values were T_e = 2 to 12 eV and $n_e = 10^{11}$ to 10^{14} per cm^3. The penetrations measured were those of the fields producing the plasmas. (auth)

32430 STRUCTURE OF AND PARTICLE ORBITS IN NEUTRAL PLASMA SHEATHS. Enoch, Jacob (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 1294-1304(June 1969).

Self-consistent solutions of the Vlasov equations for a locally neutral plasma sheath are obtained for three cases: (a) a field-reversed confined sheath, (b) a sinusoidal magnetic field solution, and (c) a non-field-reversed confined sheath solution. In the first two cases, exact analytic solutions are obtained; in the third, an approximation is obtained for the interior structure of the sheath. Particle trajectories are calculated by two different methods for the interior region of the non-field-reversed sheath. (auth)

32431 A PHENOMENOLOGICAL THEORY OF THE NEGATIVE GLOW OF ANOMALOUS GLOW DISCHARGES CONSIDERING VOLUME RECOMBINATION. Heisen, A.; Wunderer, B. (Univ., Munich). Z. Phys., 224: 237-56(1969). (In German).

Two-dimensional solutions of the quasi-neutral diffusion equation of a cylindrical negative glow plasma are computed numerically with regard to the radial contraction of the electron beam generating the plasma and to volume recombination terms linear or quadratic in the plasma density. Comparing calculated to measured maximal plasma densities (for H_2 discharges) it can be shown that a linear recombination mechanism seems to prevail. Attachment coefficients calculated are about 2 to 5×10^5 $(torr\ sec)^{-1}$. An analytic description of the negative glow is given for the attachment case; it also allows to treat an additional generation by electron–gas collisions. Both the beam contraction and attachment lead to a pressure independence of calculated plasma efficiencies, as was found experimentally. (auth)

32432 KINETIC THEORY AND TRANSPORT PROPERTIES FOR A MAGNETIZED PLASMA. Choi, Duk In. Boulder, Colo., Univ. of Colorado, 1968. 156p.

Thesis.

When the external magnetic field is large enough such that the gyrofrequency becomes of the same order of the plasma frequency, the collision integral of the kinetic equation should account for the effect of the magnetic field on the collision processes. Using the Klimontovich–Dupree–Chappell formalism (or the microscopic theory), a kinetic equation is derived for a plasma in the presence of a strong external magnetic field including the transverse interactions. The resulting equation agrees with that of Rostoker, Aamodt and Eldridge, who used the test particle method. Landau equations with and without the external magnetic field were obtained by the use of the microscopic theory approach. The kinetic equation is solved in the presence of strong magnetic field by the Chapman–Enskog method and the electrical and thermal conductivities and the ion viscosity in the strong magnetic field limit were obtained. They show markedly a different behavior from those obtained using the Boltzmann collision integral. Based on the functional formalism of Brittin–Chappell, where they treat the electric and magnetic field quantities on the same basis as the particle density function in phase space, the general conservation laws are derived. These conservation laws are exact and include the transverse interactions. These conservation laws then provide a rigorous foundation for magnetohydrodynamics. (Disser. Abstr.)

32433 BUNCHING OF DIAMAGNETIC PLASMA IN A MAGNETIC DIPOLE FIELD. Wo Hong An; Tverskoi, B. A. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 185: 289-92(Mar. 11, 1969). (In Russian).

The problem of the equilibrium configuration of diamagnetic plasma in a magnetic dipole field was analyzed for the case of a plane magnetic dipole with complex potential. A dimensionless variable $\xi = (iB^*/B_0)^{1/2}$ was introduced into the problem. In the plane studied, ξ, the sought-for configuration was reflecting on the single circular arc and the problem was reduced to finding the complex current potential around the arc near the boundary under certain circulating conditions. (R.V.J.)

32434 LINEAR-RESPONSE THEORY AND IRREVERSIBILITY IN A STRONG MAGNETIC FIELD. Budd, H. F. (Ecole Normale Superieure, Paris). Phys. Rev. Lett., 22: 1248-51(June 9, 1969).

A consistency condition is derived for the linear-response formulation of transport phenomena in a strong magnetic field. It is shown that despite the convergent results obtained for the transport coefficients this formulation may be totally inconsistent and yield, in fact, divergent corrections to the occupation probabilities. The relation of this previously unrecognized difficulty to irreversible kinetic theory is established. (auth)

Production

Refer also to abstract 32315.

32435 LASER PLASMA PRODUCTION SYSTEM FROM A SINGLE SOLIDIFIED GAS PARTICLE. Sekiguchi, Tadashi; Hirosawa, Haruto (Tokyo Univ.). Tokyo Daigaku Kogakubu Kijo, A, No. 6, 36-7(Dec. 1968). (In Japanese).

Any kind of gas except helium (particularly Xe and H_2 in the experiments) is frozen into a solid column, 0.4 mm in diameter and about 0.7 mm long, which is moved in a vacuum chamber by a thin pipe and remains hanging down. The column is reshaped into a desired size at its base as a result of gradual evaporation, and is then cut by a low-power laser pulse thermally or by a thin blade mechanically. The light signal scattered from the falling column triggers a Q-switched laser (≳100 MW). The laser light pulse is focused on a particle isolated at the center of a vacuum chamber to produce high-temperature and high-density plasma. Plasmas produced by such a unique method will offer most appropriate means to study the interaction mechanism between hot, dense plasmas and magnetic field configurations of any type. (NSA of Japan)

32436 PRODUCTION OF A DENSE DEUTERIUM PLASMA IN A STRONG MAGNETIC FIELD BY A GIANT LASER PULSE (HOTICE EXPERIMENT). Ascoli-Bartoli, U.; Brunelli, B.; Caruso, A.; de Angelis, A.; Gatti, G.; Gratton, R.; Parlange, F.; Salzmann, H. (EURATOM-CNEN, Rome). pp 917-24 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

An experiment of plasma production by means of a short-duration giant laser pulse, focused on a deuterium pellet, is described. The plasma can be produced in a pre-existing strong magnetic field parallel to the optical axis. The deuterium targets are produced with a cryostat and injected in such a way that they pass very close to the optical axis. The total number of deuterons in the single target is about 5×10^{17}. The results reported here are mainly concerned with the production of plasma in absence of a magnetic field. There are indications that, at least during a period around 30 to 40 nsec, the system consists of two phases: a "high"-density phase with a density of the order of solid state and a temperature of about 4 eV, whose outer layers are heated by the laser and continuously expand, forming a "low"-density phase with a density of about 10^{19} cm^{-3} and a temperature of approximately 100 to 200 eV. Furthermore, the high-density phase is —as a reaction to this process— strongly accelerated in the direction of the laser light. Preliminary measurements with a strong magnetic field have been carried out. (auth)

32437 PRODUCTION AND MAGNETIC-FIELD CONFINEMENT OF LASER-IRRADIATED SOLID PARTICLE PLASMAS. Haught, A. F.; Polk, D. H.; Fader, W. J. (United Aircraft Research Labs., East Hartford, Conn.). pp 925-43 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The focused high-intensity beam from a Q-spoiled laser has been used to form a high-temperature, high-density plasma from a single 10 to 20-micron-radius solid particle of lithium hydride which is electrically suspended in a vacuum environment free of all material supports. Time-resolved charge-collection measure-

ments of the freely expanding plasma have shown that a high degree of ionization of the 10^{15} atoms in the lithium hydride particle can be achieved and that the plasma produced is essentially spherically symmetric in density over the full 4π solid angle. Time-of-flight studies of the plasma expansion have shown that average electron and ion energies exceeding 200 eV are obtained and that the plasma expansion rate, like the plasma density, is spherically symmetric. No charge separation or separation of the lithium and hydrogen ions is observed in the expanding plasma. Numerical calculations of the plasma formation and expansion have been made using a one-dimensional spherical hydrodynamic model and, on the basis of the results obtained, an integrated similarity model has been developed for calculations of the plasma time history and energy over the range of conditions employed in the experiments. These calculations, which include the effects of laser pulse time history, fraction of the incident beam occupied by the expanding plasma, radial density and velocity gradients within the plasma, and spatial distribution of the incident laser energy, give results for the plasma radial density distribution, velocity profile, and plasma energy in good agreement with those determined experimentally over the full range of the present measurements. Measurements have been carried out to examine the interaction of these laser-produced plasmas with mirror, cusp, and minimum-B magnetic fields. Experiments with mirror and minimum-B magnetic fields up to 8 kG show that plasmas with densities of 10^{12} to 10^{13} cm^{-3} are confined for times of 5 μs (mirror) and 10 μs (minimum-B) and that a measurable amount of plasma is still present within the containment volume at times as late as 20 μs (mirror) and 100 μs (minimum-B), compared with the 0.3 μs "lifetime" associated with the free plasma expansion. The plasma decay rate in the 8-kG minimum-B magnetic field is consistent with that for Coulomb collisional scattering loss into the magnetic-field loss cones. (auth)

32438 HEATING AND CONFINEMENT STUDIES OF LASER-IRRADIATED SOLID-PARTICLE PLASMAS. Lubin, M. J.; Dunn, H. S.; Friedman, W. (Univ. of Rochester, N. Y.). pp 945-65 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The plasma formed by vaporization of a small solid particle of lithium hydride, electrodynamically suspended in hard vacuum, with a "tailored" laser pulse is studied. It is shown that proper shaping of the initial leading edge of the laser pulse such that the particle is completely vaporized prior to the main heating and subsequent expansion leads to enhanced energy absorption. At peak laser powers of 1.51×10^9 W the peak measured temperatures in the expanding plasma, with no confining magnetic field, are in excess of 160 eV, while the measured average energies per particle in a fully ionized symmetrically expanding plasma containing 10^{16} ions, are 1 keV. Temperature measurements are carried out by light scattering and expansion energy is obtained using integrated charge collection probes and a 5.3 mm microwave interferometer. Preliminary work on the interaction of this expanding plasma with a uniform magnetic field is presented. The theoretical radiation expected in the case interaction with the uniform field is examined. In particular, the radiation intensity is presented for (a) the dipole radiation due to surface currents during the initial stages of expansion, (b) cyclotron surface radiation and (c) the volume cyclotron radiation during the later stages of the plasma expansion. A comparison of far-infrared and millimeter measurements displays reasonable agreement with the predicted development in time of the plasma radiation. Results of initial confinement studies in a nonzero minimum-B magnetic field generated by a "baseball winding" are presented. Measurement of containment times with a microwave interferometer and flux probes indicate that densities of 10^{13} cm^{-3} are retained in a volume of 30 cm^3 for times in excess of 400 μsec in a 20-kG field. Of particular interest is the apparent flute-like behavior at fields below 8 kG. (auth)

32439 PRODUCTION OF A HOT PLASMA AT HIGH LEVELS OF RADIOFREQUENCY POWER DENSITIES. Lisitano, G.; Caldirola, P.; Barassi, N.; Fontanesi, M.; Sindoni, E. (Univ. of Milan). pp 415-22 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

A plasma beam of small diameter was produced and heated up to high electron temperatures by using high levels of rf power densities inside one short section of the beam. The plasma was produced in the collisionless regime and was fully ionized. The electron temperature and density could be varied smoothly in the range of 5 to 100 eV and 10^9 to 10^{11} cm^{-3}, respectively. The rf-coupling system consists of a new non-resonant structure enabling efficient coupling under conditions of λ_{rf}/D up to 20 (λ_{rf} is the free space wavelength of the exciting frequency and D is the diameter of the plasma beam). With the structure immersed in an axially nonuniform magnetic field, conditions were studied for space-charge acceleration of the plasma. The rf power was transferred transversely to the electrons in a region of electron gyromagnetic resonance outside the coupling structure. The kinetic power flux along the beam was measured pyrometrically. It can be of the order of 50 to 60 W/cm^2 at rf power levels of 100 W, 2.4 Gc, and a plasma diameter of 12 mm. Plasma profile measurements of the ion saturation current and of the floating potential show a bell-shaped concentration of particles inside a positive potential well of 1 kV/cm. This experiment demonstrates that consistent heating of plasma can be achieved by concentrating low levels of rf power into a small-volume section of the plasma beam. The plasma is relatively quiet, i.e., $\Delta n/n \approx 0.08$. The long mean free path for ions and electrons and the high rf power density per unit plasma volume (≈15 kW/liter) show the importance of these hot-plasma studies for CTR problems. (auth)

32440 Cs-PLASMA IN THE GARCHING OCTOPOLE W V. Erickson, C. W.; von Gierke, G.; Grieger, G.; Rau, F.; Wobig, H. (Institut fuer Plasmaphysik, Garching, Ger.). pp 339-50 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

In the Octopole, a Cs plasma in the density range of typically some 10^9 cm^{-3} is produced by contact ionization with an ion input flux of the order of $\Phi = 10^{15}$ s^{-1}. The influence of an applied azimuthal magnetic field is studied. In accordance with a previous experiment, an improvement in density by a factor of 10 is found, when superimposing $B_\varphi = 65$ G. Axial density profiles show a maximum near the lower small separatrix. No appreciable azimuthal density gradient is found, however a large density gradient parallel to the magnetic field towards the rings is to be concluded. n proportional to Φ is found. The experimental confinement time is $\tau_\varphi \approx 20$ ms for $B_\varphi = 65$ G and $\tau_0 = 2$ ms for $B_\varphi = 0$. The confinement is discussed in terms of a collisionless model where nonconservation of magnetic moment and large Larmor radii lead to recombination of particles at the rings. (auth)

32441 DEUTERIUM PLASMA PRODUCED BY SUBNANOSECOND LASER PULSES. Caruso, A.; De Angelis, A.; Gatti, G.; Gratton, R.; Martellucci, S. (EURATOM-CNEN, Rome). Phys. Lett., 29A: 316-17(June 2, 1969).

The production of deuterium plasma by a 10^{11}-sec long, 0.05- to 1.3-joule energy, Nd^{+3} glass laser pulse is reported. The experimental results are compared with a theoretical model. (auth)

Stability

Refer also to abstracts 32511 and 32531.

32442 (LA-4056-TR) STABILIZATION OF A PLASMA BY HIGH-FREQUENCY ELECTROMAGNETIC FIELDS. Demirkhanov, R. A. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from pp 809-918 of 2nd International Conference on the Interactions Between Oscillating Fields and Plasmas, Saclay, France, January 1968. Volume 3. 35p. Dep. CFSTI.

A survey is given of studies of the possibility of suppressing hydrodynamic and kinetic instabilities in a magnetized plasma by means of high-frequency electromagnetic fields. Results are given for experiments carried out at the Sukhumi Physico-Technical Institute in which the possibilities of suppressing a flute hydrodynamic instability, and a drift-type microinstability by high-frequency fields were studied. The problems of the interaction of large-amplitude high-frequency fields in the region of the skin layer are discussed. Results of a study of the plasma-column equilibrium in a torus in the presence of helical high-frequency electromagnetic fields of the quadrupole type are also given. (auth)

32443 (NP-tr-1774) EXPERIMENTAL RESULTS ON THE SUPPRESSION OF THE FLUTE INSTABILITY BY A FEEDBACK SYSTEM ON PHOENIX II. Report on Work Carried Out During January 1969. Chuyanov, V. Translated for Culham Lab., Abingdon, Eng., from the Russian. 23p. (CTO-598). Dep.

The stabilizing system and diagnostic apparatus are described. Loss measurements were made and it was found that certain modes of the instability could be suppressed at these densities. (M.O.W.)

32444 STABILIZATION OF NONLINEAR INSTABILITIES BY MEANS OF DISSIPATION. Stenflo, L.; Wilhelmsson, H. (Univ. of Uppsala). Phys. Lett., 29A: 217-18(May 19, 1969).

The set of "random-phase" equations describing wave interaction with dissipation is solved exactly. The critical limit for stabilization is determined. (auth)

32445 PLASMA-CURRENT MULTIPOLE EXPERIMENTS. Ohkawa, T.; Voorhies, H. G. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev. Lett., 22: 1275-7(June 16, 1969).

The magnetohydrodynamic equilibrium and stability of the plasma-current multipole configuration have been demonstrated experimentally. (auth)

32446 SUPPRESSION OF A DRIFT-TYPE INSTABILITY IN A MAGNETOPLASMA BY A FEEDBACK TECHNIQUE. Keen, B. E.; Aldridge, R. V. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Rev. Lett., 22: 1358-61(June 23, 1969).

The experimental details and the results obtained when using a feedback system to suppress drift instabilities present in a magnetoplasma are presented. (auth)

32447 STABILIZATION OF DISSIPATIVE DRIFT INSTABILITY BY A HIGH-FREQUENCY FIELD. Lepechinsky, Dimitri; Rolland, Paul (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 268: 957-60(Apr. 9, 1969). (In French).

A theory of stabilization of the instability of dissipative drift motion by an hf field is presented based on the model of two fluids and causing the hf fluctuation interactions to interfere with those of the drift motion waves. (tr-auth)

32448 STABILITY OF E-LAYER AND PLASMA IN ASTRON CONFIGURATIONS. Benford, G.; Book, D. L.; Christofilos, N. C.; Fowler, T. K.; Neil, V. K.; Pearlstein, L. D. (Univ. of California, Livermore). pp 981-95 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Stability criteria are derived for Astron configurations, including stability of the E-layer alone, E-layer beam-plasma interaction, and stability of plasma confined in a reversed-field configuration created by the E-layer. It is shown that energy spread among E-layer electrons has a strong stabilizing influence on modes driven by the E-layer, as was shown previously for the negative mass and tearing modes. For example, energy spread strongly attenuates a beam-plasma instability in which the E-layer excites hybrid oscillations in a background plasma so that weak effects such as collisions can eliminate the residual instability. Another stabilizing mechanism is image currents in the tank walls. These stabilize a mode due to wall resistivity and precession of the E layer in the external mirror field B_0 by reversing the sense of precession. Stability is predicted when ζ is of the order of a few per cent, where ζ is the reversal parameter (ratio of the E layer field to B_0). Low-frequency stability of the plasma confined by the closed-line configuration inside the E layer is examined. The unique feature is that the magnetic gradient drift is favorable everywhere along the closed lines. Consequently, $\oint dl/B$ stable configurations can be constructed in which this favorable drift overcomes the bad curvature drift due to line closure. For example, in the limit of small aspect ratio elliptical field lines lead to zero average drifts and marginal stability. Reducing the curvature in the strong-field region (flattening) produces a stable configuration. Since the unfavorable drift occurs in the weak field region and only for particles of "large" parallel velocities, modes driven by particles stalling in this bad field region do not occur. Moreover, current distributions are exhibited which have favorable average drift everywhere along the line eliminating the bulk of the universal-type instabilities. The limiting plasma pressure stable to interchanges is determined. (auth)

32449 STABILITY OF A PLASMA IN A STRAIGHT TWO-TURN FIELD WITH HELICAL SYMMETRY. Rosinskii, S. E.; Rukhlin, V. G.; Rukhadze, A. A. (Inst. of Physics, Moscow). pp 863-98 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The problem of stable containment of a plasma in a magnetic field with helical symmetry is studied. Using the collisionless kinetic equation of Vlasov, the potential oscillations are studied in a low-pressure plasma to conditions such that perturbation of the vacuum equilibrium magnetic field by the plasma can be neglected. Instabilities developing in times short enough so that particle blockage effects are not significant, and also instabilities governed largely by the presence of blocked particles are considered. Particular attention is given to elucidating the effects of complex geometry, especially the influence of local shear and variable curvature on instability growth. Analyses of oscillation stability have shown that oscillations which are not too highly localized (developing in times small compared with the time of particle transit over a distance equivalent to the helical winding pitch) are well stabilized by mean square local shear. This stabilizing effect is much stronger than the square of mean shear which stabilizes strongly localized oscillations. In these conditions, the flute instability does not show up at all. The oscillations can be unstable only as a result of the Larmor drift of the particles, when the increment of unstable perturbations is small compared with the Larmor drift frequency. However, these instabilities are not dangerous either, since they are easily stabilized by mean square local shear. Particle blockage and variable curvature of the lines of force of the magnetic field result in a number of new instabilities, apart from those already found in the work of Kadomtsev et al., and Rosenbluth et al. Some of these are hydrodynamic and can be stabilized by shear. When one allows for the thermal velocity spread of the particles a number of kinetic instabilities appear, some of which are in fact difficult to deal with because they are not adequately stabilized by shear. (auth)

32450 NON-LINEAR INSTABILITIES IN AN INHOMOGENEOUS PLASMA. Coppi, B.; Laval, G.; Pellat, R.; Khiet, Tu (EURATOM-CEA, Fontenay-aux-Roses, France). pp 795-810 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In French).

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The low-frequency drift modes of a low-pressure isothermal inhomogeneous plasma can be stabilized if the shear of the magnetic field lines exceeds a critical value given by the expression $r/L_S = (1/2\sqrt{2})\,(a/r)$, where L_S is the shear length, r the characteristic length of density variation, and a the ion Larmor radius. It is shown that if $r/L_S < (1/2\sqrt{2})\,(a/r)$, it is possible to achieve a substantial reduction in the rate of growth of the modes and thereby satisfy the conditions for applying the theory of weak turbulence. If $a/r \ll 1$, the normal modes are very easily stabilized, but convective perturbations are known to persist and these can become amplified by propagating in the direction of the density gradient. These perturbations can be excited only by thermal fluctuations, which are explicitly calculated. The maximum amplitude of the relative density fluctuations are then deduced. If the plasma is fairly dense, weak shear is sufficient to maintain these fluctuations at a level at which the resulting diffusion is negligible. In both these cases of weak turbulence, however, nonlinear instability may arise and cause diffusion that is far more substantial than the linear theories predict. On the one hand, it is noted that the energy of the drift waves is negative if their phase velocity parallel to the magnetic field is greater than the thermal velocity of the electrons, and the development of the nonlinear instability which results as a function of shear is discussed. On the other hand, it is shown that nonlinear reflection of the convective perturbations may occur before they reach the region where they would be absorbed by the ion Landau effect. The threshold which the amplitude of the initial perturbations must pass for a nonlinear instability to develop is estimated. (auth)

32451 THE INFLUENCE OF ELECTRICAL RESISTIVITY ON THE MHD STABILITY OF STATIONARY EQUILIBRIA. Friedel, H.; Unteregger, P. (Univ. of Innsbruck). pp 811-17 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

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A general class of equilibrium configurations with a zero-order fluid velocity is investigated using a method similar to that of Coppi. The hydromagnetic system under consideration is characterized by finite electrical conductivity, zero viscosity and zero thermal conductivity. Using a Lagrangian description, an equation of motion governing small displacements of the system about the equilibrium is found. Furthermore, general criteria determining the influence of electrical resistivity on modes stable or marginally stable in the nondissipative case are derived. For infinite electrical conductivity we get agreement with the results found by Frieman and Coppi. Finally, a general formalism for

treating instability problems with arbitrary dissipative effects is presented. (auth)

32452 DRIFT INSTABILITY OF A NON-MAXWELLIAN PLASMA. Nezlin, M. V. (Inst. of Atomic Energy, Moscow). pp 763-76 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The instability of a spatially inhomogeneous plasma that incorporates beams of charged particles (electrons) was investigated. This so-called drift-beam instability is based on the same physical mechanism that causes the drift ("universal") instability of a collisionless plasma with a Maxwellian electron velocity distribution. However, the drift-beam instability possesses a number of peculiarities that permit one to investigate the drift instability mechanism more effectively than is possible in the case of a Maxwellian plasma. According to the theory, the main differences between drift-beam instability and normal drift instability are: (1) the instability begins at some threshold (critical) beam density (in the case of a Maxwellian plasma there is no particle density threshold); (2) the critical beam density (n_{1c}) is very strongly dependent on the electron velocity and beam geometry, the strength of the magnetic field, and the ratio of the electron density of the cold plasma to the beam density; and (3) the nature of the dependence of n_{1c} on the fundamental parameters of the system is determined by the spatial structure of the electron-ion oscillations under consideration. In particular, if the oscillations possess axial symmetry, then the dependence in question is the same as for "normal" (nondrift) beam instability. The above-mentioned peculiarities of drift-beam instability were the prerequisites for model experiments carried out to obtain information about the mechanism of drift instability. In these experiments the authors studied the excitation conditions (thresholds), dispersion properties and spatial structure of the drift-beam instability. They found good agreement with the fundamental propositions of the theory. It was shown experimentally that the electron-ion drift-beam instability expresses itself in phenomena such as the interruption of the beam current in the plasma and the heating of the plasma ions to energies of the same order as those of the beam electrons. The latter phenomenon was used successfully in filling magnetic mirror traps with a plasma having an ion temperature of about 1 keV and a density of about 10^{11} cm^{-3}. (auth)

32453 MAGNETIC EQUILIBRIUM IN FAST THETA PINCH. Bingham, R. L.; Goldman, L. M.; Kilb, R. W. (General Electric Research and Development Center, Schenectady, N. Y.). pp 667-75 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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The effects of the end configuration on the equilibrium and stability of zero-bias θ-pinch plasmas were investigated. It was demonstrated that it is the hot external plasma and favorable field curvature in and beyond the mirror region that provide an average magnetic well for the plasma and, therefore, an equilibrium position. The field curvature effects were determined by initially imploding the plasma several centimeters from the magnetic axis of the coil and measuring the subsequent plasma motion. This motion was measured under five different conditions: (1) normal unterminated plasma; (2) quartz discs terminating the plasma in the mirror throat; (3) quartz discs terminating the plasma 5 cm inside the mirror peak; (4) one quartz disc terminating one end of the plasma inside the mirror; (5) molybdenum disc terminating the plasma 6 cm beyond the mirror peak. In case (1) the plasma is accelerated toward the magnetic axis at a rate which agrees quite well with a rate calculated from a mean $J \times B$ force averaged over the length of the plasma, assuming the plasma density falls off like the magnetic field density beyond the mirror planes. In case (2) the plasma does not move at all during the time of observation consistent with the computation, while in case (3), where all the curvature is unfavorable, the plasma generally does not move or occasionally moves slowly away from the magnetic axis, but at a rate much smaller than the computed one. Case (4) clearly demonstrates the absence of strong line-tying at quartz surfaces in these experiments by the fact that having the plasma in contact with one quartz disc does not prevent the plasma from drifting towards the magnetic axis. The measured acceleration in case (4) is again in good agreement with the calculated rate. The molybdenum discs beyond the mirror peak in case (5) did not prevent plasma drift toward the axis, and in fact appeared to accentuate rotational instabilities near the axis. This again shows that line tying at conducting surfaces is not a dominant effect in determining the equilibrium position. The acceleration in the center plane was calculated. (auth)

32454 CHARACTERISTICS OF MICROINSTABILITIES IN A HOT ELECTRON PLASMA. Ikegami, H.; Ikezi, H.; Kawamura, T.; Momota, H.; Takayama, K.; Terashima, Y. (Nagoya Univ., Japan). pp 423-32 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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A 150-keV hot-electron plasma was produced in a mirror by pulsed high-power microwaves. Plasma densities of 10^{12} electrons/cm^3 were observed. During the stable afterglow, an instability was triggered artificially by irradiation of a small microwave pulse. The instability was characterized by a sudden disappearance of hot electrons and a strong burst of microwaves. The instability was both experimentally and theoretically identified to be the electron cyclotron instability. The rapid plasma loss was also interpreted by the diffusion of particles in velocity space due to the microinstability. (auth)

32455 EXPERIMENTAL INVESTIGATION OF PLASMA STABILITY IN A STRONG HIGH-FREQUENCY ELECTRIC FIELD. Demirkhanov, R. A.; Khorasanov, G. L.; Sidorova, I. K. (Sukhumi Inst. of Physics and Tech., USSR). pp 449-59 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The behavior of a thermally ionized cesium plasma in a high-frequency electric field was investigated. The following problems relating to the interaction between high-frequency fields and a plasma were investigated experimentally: (1) the effect of a high-frequency longitudinal current on the amplitude of drift oscillations occurring spontaneously in a bounded magnetized plasma; (2) excitation of low-frequency plasma oscillations by high-frequency currents flowing in the plasma; and (3) collisionless plasma heating by a powerful high-frequency electric field. The experimental conditions were as follows: plasma density (1 to 5) $\times$ 10^{10} cm^{-3}; initial temperature $T_e \sim T_i \sim 0.2$ eV; degree of ionization 20 to 30%; longitudinal constant magnetic field 2000 to 4000 Oe; and natural drift oscillation level $e\varphi/T \sim 10^{-2}$. A variable electric voltage at frequencies ranging from 0.3 to 20 Mc was applied to the end electrodes of a Q machine, so that a longitudinal high-frequency current was excited in the plasma. It was found that a high-frequency electric field of 0.1 to 0.3 V/cm, in which the electron oscillation speed is (2 to 6) $\times$ 10^6 cm/s ($V_{Ti} \ll U_0 < V_{Te}$), substantially reduces the level of the natural drift oscillations of the plasma, the frequency of the first harmonic of the drift oscillations increasing by 20% while the initial plasma parameters change insignificantly. Suppression of the drift oscillations is accompanied by excitation in the plasma of a new low-frequency branch of oscillations. The frequencies of these oscillations lie within the range characteristic of ionic sound and its harmonics, and are not dependent on the strength of the magnetic field. As the strength of the high-frequency field rises to above 0.3 V/cm, the plasma drift oscillations remain suppressed and the intensity of the ion-acoustic oscillations excited by the high-frequency current increases. The development of ion-sound waves in the plasma leads to a substantial change in the plasma parameters. At the same time, the electron temperature of the plasma reaches several electron-volts. The observed heating is probably connected with the collective processes which occur in the plasma as a high-frequency current passes through it. Evidence in favor of this idea is provided by the anomalously high active resistance of the plasma to the passage of the high-frequency current. The dependence of the amplitude and frequency of the first harmonic of the ion-acoustic oscillations on the frequency of the hf field was measured. The experimental data indicate that the efficiency of turbulent plasma heating rises with increasing hf-field frequency. (auth)

32456 HIGH-FREQUENCY STABILIZATION OF ROTATING PLASMA CYLINDER PERTURBATIONS ALONG A MAGNETIC FIELD. Dubovoi, L. V.; Dyatlov, V. D. (Inst. of Electrophysical Apparatuses, Leningrad). pp 469-75 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The effect of a longitudinal high-frequency current on the dynamics of long waves in a plasma cylinder in an axial magnetic

field was studied. To excite the instability the plasma was rotated in quasi-stationary shear fields. The spatial and time characteristics of the instability were measured with a system of Langmuir probes. With amplitudes of the hf current magnetic field B_φ greater than a certain critical value B_k, the discharge instability vanishes. This effect of instability suppression has a threshold, and the magnitude of B_k satisfies the condition $B_k/B_z \sim$ const $\langle K_z/K_\varphi$. Different mechanisms that may explain this phenomenon are discussed; in particular, a possible mechanism in these experiments may be a shorting of the polarization fields in the perturbation which occurs with periodic rotation of the total magnetic field vector relative to the wave vector K_z. (auth)

32457 HIGH-FREQUENCY STABILIZATION OF A TOROIDAL CURRENT DISCHARGE IN A MAGNETIC FIELD. Roife, I. M.; Vasilevskii, M. A. (Inst. of Electro-physical Apparatuses, Leningrad). pp 477-81 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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Results are presented of research in which a longitudinal high-frequency electric field was used to stabilize a toroidal current discharge in a magnetic field, in conditions where the Shafranov–Kruskal criterion was substantially violated. The experiments were carried out with a current of 2 to 15 kA in a magnetic field of 0.5 to 10 kOe, with an initial pressure in the chamber of 10^{-2} to 10^{-3} mm Hg. The small diameter of the plasma ring was about 1.5 cm, the large diameter about 70 cm. The small diameter of the quartz chamber was 6.0 cm. Results obtained with a toroidal high-frequency discharge in a chamber enclosed by a conducting sheath with many cuts and with one cut perpendicular to the large diameter of the torus are discussed. The results of these experiments make it possible to draw a conclusion that a high-frequency stabilization of a toroidal current discharge can be realized. (auth)

32458 PROBLEM OF DYNAMIC STABILIZATION. Berge, G. (Univ. of Bergen, Culham Lab., Abingdon, Eng.). pp 483-95 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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The basic equations used are the ideal magnetohydrodynamic equations. A general theory is developed for investigating the stability of a plasma with an oscillatory motion. The oscillatory motion is assumed to be forced on the system and controlled from outside. It takes place around some equilibrium of the system. This equilibrium may be "weakly" unstable or only marginally stable. "Weakly" unstable in this context means that the characteristic frequency of any instability present in the static system must be much less than the frequency of the forced oscillations. The aim of the investigation is to determine whether the dynamic effect of such oscillations can improve the stability of the system. First, a vector equation is derived for the Lagrangian displacement vector of an arbitrary fluid element. This equation determines the stability of a hydromagnetic fluid in an arbitrary motion. Then the assumption of a small-amplitude periodic motion about some equilibrium is made. To deal with the explicit time dependence of the problem, the multiple-time-scale method is used. An expansion is made in terms of a small parameter associated with the applied frequency and the amplitude of the oscillations. The first relevant equations obtained result in stability conditions related to the energy principle for the static case. The results are not restricted to any particular geometry. The special case of a plasma separated from the vacuum region by a discontinuity surface is worked out. The general theory was applied to axially symmetric plasma columns in the limit $\beta = 1$ (that is, no internal magnetic field). The oscillatory motion is produced and determined by the external magnetic field and the system is found to be stable for sufficiently high applied frequency. The possibility of resonances is briefly discussed. (auth)

32459 INVESTIGATION OF PLASMA INTERACTION WITH A HIGH-FREQUENCY MAGNETIC FIELD INCREASING TOWARD THE PERIPHERY. Borzunov, N. A.; Levadnyi, G. B.; Morozov, V. E.; (and others) (Inst. of Atomic Energy, Moscow). pp 497-513 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Stabilizing a straight plasma column with a current by a high-frequency magnetic multipole field demonstrated that a stabilized pinch may be observed only with a sufficiently high rate of increase in the current through the plasma. The rapid increase in current indicates that the stable pinch exists for only a short time (up to 10 microsec). Further investigations were performed to determine the conditions of formation of the pinch in a high-frequency field and the cause for its decay. The observed stabilization effect was studied both in systems with a self-excited oscillator and in systems with an impulse excited oscillator. In both cases, experience indicates essential dependence of the observed effect on the high-frequency discharge stage with which the discharge forming the plasma column begins. Obviously, the processes which take place in the high-frequency discharge excited by the currents in the stabilizing rods also have a noticeable effect on constriction of the plasma and on confining the plasma column. The research performed was partially devoted to probe-type measurements of the magnetic field and spectral measurements of the density of the high-frequency discharge plasma. It was demonstrated that, in the absence of a discharge current in sufficiently powerful high-frequency discharges, the plasma is concentrated near the axis. A longitudinal quasi-stationary magnetic field also appears in the high-frequency discharge. In the previous research the results of the observations were quantitatively compared with the theory of the dynamic stabilization technique under the assumption that the most dangerous deformation of the plasma column is the deformation with the wavelength, which is the maximum possible in the device; that is, it is twice the electrode spacing l_e. The investigations have demonstrated that the observed stabilization effect does not depend on l_e. This is evidence of the necessity of further development of the theoretical description of the interaction of a plasma column with a high-frequency multipole field. All this research was performed on devices in which the self-constricted discharge was created in straight tubes 6.0 to 20.0 cm in diameter with an electrode spacing of 30 to 80 cm, and the stabilizing field was excited by currents in rods located outside the discharge tube. The "Volna" ("Wave") system is a toroidal chamber in which the plasma is confined and heated by a magnetic field wave traveling along the axis. To compensate for the Hall drift current and the possible entrainment of the ions in the system into drift motion, two opposing traveling waves with different frequencies but moving with the same phase velocities were investigated. A set of comparable measurements was taken with both one and two waves. The effect of compensation for the drift current and its influence on the plasma confinement and stability were demonstrated. Plasma stability was studied by using waves of different spatial length (3, 12, and 16 wavelengths around the perimeter of the toroidal discharge chamber) each of which is characterized by a certain well depth (min B) for which the shorter the wavelength, the stronger the min B. The results obtained indicate that with a decrease in the spatial wavelength the plasma stability is increased. The experimental research performed indicates that the depth of the skin layer is apparently not defined by the classical relations. (auth)

32460 SUPPRESSION OF FLUTE INSTABILITY OF A PLASMA BY MEANS OF A FEEDBACK SYSTEM. Arsenin, V. V.; Zhil'tsov, V. A.; Chuyanov, V. A. (Inst. of Atomic Energy, Moscow). pp 515-29 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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Experiments to stabilize flute instability of a plasma in a field of simple mirror configuration by means of a feedback system consisting of sensing elements and amplifiers and establishing boundary conditions of a special type at the plasma surface are described. Experiments performed in Ogra II, a trap with external injection of fast hydrogen atoms, have shown that this method of stabilization makes it possible to suppress flute instability, at least in a dilute plasma ($n \sim 10^7$ cm^{-3}). When the stabilization system is switched on, the plasma losses are determined by the ion cyclotron oscillations. Fast engagement of the stabilization system makes it possible directly to observe the processes of development of flute instability. (auth)

32461 DIFFUSION AND STABILITY OF HIGH-β PLASMA IN A 8-METRE THETA PINCH. Bodin, H. A. B.; McCartan, J.; Newton, A. A.; Wolf, G. H. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 533-53 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

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Results on diffusion and stability of a plasma column 8 meters long, generated by a theta pinch, are presented and discussed. The magnetic field rises to its peak value of 25 kG in 5 μs and decays in 160 μs. The radial electron temperature and density distributions are obtained by laser and optical techniques. At filling pressures of 20-mtorr D_2 and below, the electron temperature varies from 100 eV to more than 300 eV at densities of 4 to $2 \times 10^{16}/cm^3$; beta is about 0.7. Measurements show that in the midplane the plasma is stable and free of energy losses and end effects for 10 μs at 240 eV and 25 μs at 120 eV. Anomalous diffusion found during the first two microseconds is interpreted in terms of an enhanced resistivity due to ion–acoustic oscillations excited by electron–ion streaming. The data are in agreement with theoretical results obtained from computations and from an analytical model, which also shows how the density distribution and beta depend on the line density. During the quasi-steady phase of the discharge the diffusion coefficient has been measured by comparing the time variation of the density distribution with the results of computations assuming classical and other diffusion rates, in conditions where the ratio Bohm/classical diffusion was varied from 20 to 200. In all cases, good agreement with classical diffusion is found, and the experimental error is such that the diffusion rate is unlikely to exceed $1/_{20}$ of the Bohm value. Results on the growth rate and axial dependence of the induced m = 1 instability for axisymmetric MHD unstable bulges are described and compared with calculations using an MHD model. Good agreement is found which suggests that, for this most dangerous m = 1 mode, the theta pinch is well described by MHD theory. (auth)

32462 LINEAR θ-PINCH EXPERIMENTS RELATED TO THE STABILITY OF A TOROIDAL θ-PINCH OF LARGE ASPECT RATIO. Little, E. M.; Newton, A. A.; Quinn, W. E.; Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). pp 555-65 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

In a high-β, toroidal θ-pinch (compression field B_e) the outward radial force ($\approx \beta B_{ze}^2 a^2/4R$) due to the major curvature 1/R can be neutralized by introducing radial excursions $a\delta l \cos l\theta \cos kz$ about the minor radius a of the plasma surface. Owing to the periodic regions of unfavorable curvature and to the high $\beta(\approx 0.8$ on axis), the equilibrium is grossly unstable to Haas–Wesson modes of the form $\xi_{lm}(z) \cos m\theta$. Results of experiments on one-meter θ-pinch plasmas with adiabatically applied l = 0 bumps both for hot-ion ($kT_i \approx 2$ keV) and cold-ion plasmas with maximum densities in the range from 5×10^{16} to 1×10^{17} cm^{-3}. Plasma properties β, $k(T_i + T_e)$, n, and the instability growth rates are established for known B_e by means of: (a) Faraday rotation measurements of the internal magnetic field; (b) Mach–Zehnder interferometer measurements of the density and plasma shape; and (c) streak-camera measurements of radial plasma motion. For $0.11 \leq \Delta B_e/B_e \leq 0.22$ only the m = 1 mode is observed, and its magnitude is reduced in the hot-ion cases (where end loss is also larger). Small initial negative bias fields B_0 are shown to enhance the m = 1 instability. With quasi-static longitudinal currents $I_z \leq 50$ kA the Kruskal–Shafranov modes are identified and their growth rates measured. The resistance of the current-carrying channel is determined and interpreted when I_z is alternated at frequencies of 0.6 to 0.8 MHz. No effect of I_z on the plasma density distribution about its axis is seen. (auth)

32463 INVESTIGATION OF ION-CYCLOTRON INSTABILITY IN A PLASMA BURST. Kartashev, K. B.; Pistunovich, V. I.; Platonov, V. V.; Ryutov, D. D.; Filimonova, E. A. (Inst. of Atomic Energy, Moscow). pp 335-46 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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When a burst of plasma moves along a homogeneous magnetic field, its length increases as a result of the initial thermal spread of the ions. As the burst expands, the longitudinal temperature of the ions decreases while the transverse ion temperature $T_{i\perp}$ remains at about its initial value; in other words, the ion distribution function becomes strongly anisotropic. Ion-cyclotron instability then appears in the plasma, as a result of which the longitudinal and transverse temperatures are equalized. As the burst progresses further, the anisotropy of the ions is again increased, and this is followed as before by the development of the instability, subsequent equalization of temperature, and so on. The theoretical investigations reported show that, given cold electrons, a process of this kind can be described as one-dimensional adiabatic dispersion of a gas cloud. The transverse temperature of the ions decreases. It is suggested that good use can be made of this effect in experiments on charge exchange in a plasma burst meeting a gas target. When the target is placed at a sufficient distance from the injector, the ion-cyclotron instability will reduce the transverse thermal spread of the ions and, accordingly, the dispersion of the fast atom flux will also be reduced. Results are presented of measurements carried out on the INES device, an instrument designed to produce a dense flux of fast atoms with charge exchange in a magnesium target. Measurements of oscillations at the ion-cyclotron frequency are presented. The experimental results are compared with theoretical calculations. (auth)

32464 STUDY OF MICROINSTABILITIES IN A CONFINED HOT-ELECTRON PLASMA. Jacquinot, J.; Leloup, C.; Poffe, J. P.; de Pretis, M.; Waelbroeck, F.; Evrard, P.; Ripault, J. (EURATOM-CEA, Fontenay-aux-Roses, France). pp 347-58 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In French).

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A method of pulsed heating was used to produce a hot-electron plasma in the "Bille-en-Tête" experiment. A very brief magnetic perturbation (≈ 1 μs) leads to the formation of hot electrons ($10^{10} < n_e < 5 \times 10^{11}$ cm^{-3}; $T_{e\perp} \approx 8$ keV; $T_{i\perp} \approx 400$ eV), and their confinement and stability in a magnetic bottle with static mirrors are studied. The lifetime of the hot ions is always ≈ 35 μs and is not limited by charge exchange. When the density of the hot electrons is less than 2.5×10^{10} cm^{-3}, a very long containment time is observed ($\approx 10^{-3}$ s). At higher densities, the containment time of the plasma is limited by two types of instability, each of which develops during very short periods separated by calm spells. Particular attention was devoted to the first type of instability, which occurs when the hot-electron density lies between 2.5×10^{10} and 10^{11} cm^{-3}. It is shown that this instability corresponds to a change of anisotropy in velocity space and to particle diffusion in the loss cone (the ratio $p_\parallel/p_\perp$ increases by 10% during the instability). No radial losses are observed. The frequency of the wave which accompanies the instability has been measured (≈ 0.7 ν_{ce}), as have the density and temperature of the cold plasma ($n_{ef} \approx 10 \times n_e$, $T_{ef} \approx 7$ eV). In an effort to explain these results, the dispersion equation of the electromagnetic waves propagating parallel to the magnetic field is studied. It is known that anisotropy in velocity space makes some of these waves unstable, but it is shown that the cold plasma may strongly favor their amplification. The entirety of measurements on the wave (frequency, polarization, propagation in the cold plasma, etc.) is in agreement with the theory of electromagnetic instabilities. Calculation of the power amplification of the wave gives a figure of 60 db/m (distance between mirrors 1.60 m). (auth)

32465 ION CYCLOTRON INSTABILITIES AND THE EFFECT OF MICROWAVE HEATING IN THE PHOENIX II MAGNETIC WELL. Cordey, J. G.; Kuo-Petravic, G.; Murphy, E. G.; Petravic, M.; Sweetman, D. R.; Thompson, E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 267-90 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

In the PHOENIX II neutral-injection experiment the plasma density is limited by an instability associated with the ion gyrofrequency and its harmonics. The harmonic number increases with density, a given harmonic occurring over only a narrow range. The behavior has been compared with an infinite-geometry theoretical treatment of the instability driven by the non-Maxwellian nature of the ion velocity distribution resonantly interacting with an electron plasma wave. This gives reasonable agreement with the experimental threshold densities but does not account for more detailed behavior. A finite geometry treatment has been developed that takes into account the variation of magnetic field along the plasma and the finite length. This accounts for the variation of the instability amplitude with density and the detailed line splitting. Microwave heating at the electron gyrofrequency suppresses instabilities in the higher harmonics of the ion gyrofrequency but introduces an instability at the fundamental, which persists over a wide range of density. These results are compared with the expectations of existing theory which suggests the hot electron version of the ion velocity space instability to be the most likely one present. Considerable ion-energy spreading and loss of plasma is associated with these instabilities. Direct measurements of the losses show that these are all accounted for by $v_\parallel/v_\perp$ diffusion, the radial loss being at least an order of magnitude

lower. In the heated plasma the loss rate appears to be somewhat less but considerable energy spread nevertheless occurs. The central hot ion density is increased by a factor of two, apparently by additional plasma trapping. (auth)

32466 EFFECT OF MICROINSTABILITIES ON A HOT-ION PLASMA. Clarke, J. F.; Kelley, G. G.; Lyon, J. F.; Stratton, R. F. (Oak Ridge National Lab., Tenn.). pp 291-8 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Ion cyclotron instabilities occurring in an energetic ion plasma were studied in the high-energy (540 keV H_2^+) ion injection machine DCX-2. A new microinstability, called the modified negative-mass instability, was found to dominate the behavior of the plasma. This instability limits the density of the injected plasma but produces strong ion cyclotron frequency fields that heat and trap cold ions to form a separate and denser group of high-energy ions. The optimum parameters of this group are: hot-ion density $n_+ \approx 5 \times 10^9$/cm^3; $T_{i\perp} \approx 800$ keV; plasma decay time, $\tau_s \approx 0.5$ seconds; length/Larmor radius, $L/a_i \approx 6$; plasma radius/Larmor radius, $R/a_i \approx 3$; $(T_\perp/T_\parallel)_i \approx 10^3$; and $T_e \approx 50$ eV. The density of the cyclotron-heated plasma scales linearly with power input to the injected plasma up to the highest available power. In addition to this instability, Harris modes are observed in the injected plasma, the ion-cyclotron heated plasma, and the molecular ion beam. In the latter case, electron Landau damping of short-wavelength modes has been observed. (auth)

32467 ION CYCLOTRON INSTABILITY IN THE MAGNETIC WELL OF DECA II. Brossier, P.; Lecoustey, P.; Renaud, C.; Tachon, J. (EURATOM-CEA, Fontenay-aux-Roses, France). pp 299-309 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In French).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

A deuterium plasma with a density of 10^9 to 10^{10} particles/cm^3 was confined in the magnetic well of DECA II. Study of the fast neutral atoms emitted by the plasma showed that the principal cause of plasma losses was charge exchange, with the neutral gas desorbed by the walls during injection. The perpendicular energy distribution function of the hot plasma, which has a mean energy $T_i = 1.8$ keV, is derived. The plasma is the seat of an instability at the ion cyclotron frequency and its harmonics; the instability is of low-amplitude and does not contribute measurably to the plasma losses. The spectrum of the unstable frequencies varies with the density of the plasma. For densities of the order of 10^9 particles/cm^3, instability occurs at the center of the well at the cyclotron frequency (Ω_i) and at its harmonics ($2\Omega_i$, $3\Omega_i$, $4\Omega_i$). For higher densities (~10^9 to 10^{10} particles/cm^3) the instability appears only at the first and third harmonics ($2\Omega_i$, $4\Omega_i$). The statistical width of each of the observed lines is remarkably narrow, being less than the resolution of the instruments (of the order of 3%). The azimuthal mode of the ion cyclotron frequency is m = 2; that of the first harmonic is m = 4. These modes become deformed as the plasma moves along the flux tube: the phase is maintained on a magnetic field line; the parallel wave length is at least twice the length of the plasma ($\lambda_\parallel \geq 14$ cm). The measured growth rates are of the order of 5% of the cyclotron frequency. The main source of energy for feeding the instability appears to be the nonmonotonic nature of the perpendicular energy distribution (distribution of the loss cone). Numerical study of the dispersion equation of a two-component plasma (a hot plasma having the experimental distribution as its distribution function, and a cold Maxwellian plasma corresponding to the plasma which may be produced by charge exchanges) shows that the latter reduces the density threshold above which the instability may be triggered sufficiently to explain the experimental results. This study also shows that the frequency $\omega = \Omega_i$ is stabilized when the proportion of cold plasma exceeds 10%, the most unstable frequency then being $\omega = 2\Omega_i$. (auth)

32468 STUDY OF ION-CYCLOTRON INSTABILITY IN THE PR-5 DEVICE. Kanaev, B. I.; Yushmanov, E. E. (Inst. of Atomic Energy, Moscow). pp 319-33 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The basic experimental conditions were as follows: magnetic field at the center, H = 2800 G; longitudinal mirror ratio 1.7; radial mirror ratio 1.1 to 1.2; density at the axis ~10^{10} cm^{-3}; mean ion energy ~1 keV; electron temperature ~20 eV; and neutral gas pressure ~10^{-7} mm Hg. The plasma configuration was determined by measuring the flow of charge-exchange particles from different regions of the trap by means of collimated detectors. It was found that the length of the plasmoid was 20 to 30 cm and that the radial distribution was nearly exponential with a characteristic length of 3 cm. The anisotropy index, calculated on the basis of the longitudinal density distribution, was approximately 20. During an instability burst, there was an abrupt density decrease, mainly in the outer layer of the plasma, while the density at the center of the plasma changed only slightly. The wave structure was investigated with the help of electrostatic probes arranged logitudinally and azimuthally in the trap. It was found that the wave phase was constant in the longitudinal directions, i.e., there was a standing wave of the first or zero mode. In the azimuthal direction, waves were observed with mode number m = 2, 3 and probably 4 traveling in the direction of ion rotation. The amplitude of the oscillations decreased with increasing mode number; the previously noted division of jumps into types according to the extent of the density decrease was associated with the excitation of different oscillation modes. The oscillation frequencies also decreased with increasing m, but were close to the ion-cyclotron frequency. The excited oscillations remain regular throughout the burst (~50 μs) and do not produce random turbulence. In many cases, two oscillations with different modes — but both regular — exist together. The minimum characteristic times for the growth and decline of the oscillation amplitude are of the order of 5 μs. According to estimates for a wave of the second mode, the energy contained in the electric field of the oscillations can be as much as 10% of the initial plasma energy. (auth)

32469 CYCLOTRON INSTABILITY AND ABRUPT PLASMA DENSITY DECREASES IN ADIABATIC TRAPS. Kadomtsev, B. B.; Pogutse, O. P. (Inst. of Atomic Energy, Moscow). pp 125-40 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Frequently observed phenomena in adiabatic magnetic mirror traps are cyclotron oscillation bursts with ejection of part of the plasma from the trap. Although these phenomena are fairly general, their detailed behavior is strongly dependent on the actual experimental conditions. In this paper, which is a theoretical study of cyclotron instability, the authors have in mind experiments carried out by M. S. Ioffe and co-workers in which cyclotron oscillations of the flute type are observed. The fact that these oscillations have a fairly large wavelength across the field lines conflicts with the theory of cyclotron instability for a homogeneous plasma. The inhomogeneity of the plasma is taken into account from the very outset. It is shown that surface cyclotron waves in which electron and ion charge separation occurs only near the plasmoid boundary can propagate in such a plasma. As was also observed in the experiments of Ioffe and co-workers, these waves travel along the azimuth in the same direction as the ions. The frequency of the oscillations is close to the upper hybrid ion frequency, and the oscillation buildup mechanism is similar to the negative mass instability. The question of an abrupt decline in plasma density during a cyclotron oscillation burst is discussed. The results obtained are compared with experimental data. (auth)

32470 RESONANT LOSS-CONE INSTABILITIES IN MIRROR-CONFINED PLASMAS. Beasley, C. O. Jr.; Dory, R. A.; Farr, W. M.; Guest, G. E.; Sigmar, D. J. (Oak Ridge National Lab., Tenn.). pp 141-9 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Resonant instabilities (having frequencies near harmonics of the ion gyrofrequency, Ω_i) which may occur in dense, energetic mirror-confined plasmas are considered. The Harris dispersion relation for electrostatic oscillations in an infinite homogeneous plasma in a uniform magnetic field is solved for a set of steady-state distribution functions chosen to simulate mirror confined or electrostatically confined plasma components. The Bers–Briggs procedure is used to obtain spatial and temporal growth rates of unstable waves, and the stabilizing effects of several parameter variations are examined through the resulting changes in (1) these growth rates, (2) marginal stability threshold densities, (3) transition densities at which growth becomes absolute rather

than convective, and (4) axial wavelengths of the unstable oscillations. The following effects were surveyed: (a) variations in the electron temperature, (b) variations in the width of the distribution functions, and (c) addition of low-temperature ions to the hot plasma. Although within the present model no set of parameters for which high-density mirror-confined plasma is stable, it appears that laboratory plasmas can be effectively stable if (1) the particle distributions approach collisional equilibrium, (2) the ion and electron temperatures are roughly equal, and (3) the plasma length does not exceed a value around 100 ion gyroradii. Low-temperature ions are impractical for stabilizing the resonant modes near higher harmonics of gyrofrequency ($\omega \approx l\Omega_i$, $l = 2, 3, 4, \ldots$). (auth)

32471 CRITERIA FOR STABILIZATION OF ELECTROSTATIC MODES IN MIRROR-CONFINED PLASMAS. **Berk, H. L. (Univ. of California, Livermore); Fowler, T. K.; Pearlstein, L. D.; Post, R. F.; Callen, J. D.; Horton, W. C.; Rosenbluth, M. N. pp 151-64 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.**

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

Improved mirror stability criteria are derived which include: stabilization of resonant cyclotron modes by the longitudinal magnetic gradient dB/dz; improved calculation of wave reflection; and stabilization by the addition of low-density, "warm" Maxwellian components partially filling the loss cone. Combined, these results, for the modes considered, point to stable mirror systems of much more favorable aspect ratios and dimensions than were indicated heretofore. If the mirror ratio R is high, the addition of a few low-energy ions effectively fills the loss cone. Thus, with R = 10, the convective loss cone mode is suppressed by adding a Maxwellian component with $n_c/n \approx 0.03$ and $T_c/T \approx 0.02$, where n_c, T_c, and n,T are the density and temperature of the Maxwellian and loss cone distributions. Similarly, the drift-cyclotron instability (lth harmonic) is suppressed if $n_c/n > (T_c/T)^{\frac{1}{2}} > (l\rho_i/R_p)^{\frac{1}{2}}$, where R_p is the plasma radius and ρ_i is the hot ion gyroradius. Various hybrid systems (torus, multiple mirrors) could provide adequate confinement of the Maxwellian ions, which contain only a small fraction of the total plasma energy. Since the absolutely unstable modes occur at frequencies close to multiples of the gyrofrequency Ω, it is expected that inhomogenetiy in the magnetic field along the lines weakens the resonance, which tends to stabilize the mode. Roughly, stabilization occurs if the spread in the gyrofrequency within a parallel wavelength exceeds the infinite medium growth rate, which predicts stability if $(1/B)/(d^2B/dz^2)\rho_i^2 > l(m/M)$, where the largest unstable harmonic number, $l_{max} \approx (\omega_{pi}^2/\Omega_i^2)^{\frac{1}{2}} (M/m)^{\frac{1}{2}}$ for $(\omega_{pe}/\Omega_e) \ll 1$ and $\approx (M/m)^{\frac{1}{2}}$ for $(\omega_{pe}/\Omega_e) \gg 1$. This heuristic conclusion is tested by a WKB calculation. The estimates of the critical length, for which the convective loss-cone mode is harmless, can be modified if a strong wave-reflection mechanism exists. Such is the case if there exists a point along the field line at which τ (the time it takes an electron resonant with the wave to return to this point) possesses an extremum with respect to the energy. This mechanism is quenched if the effective potential confining the electrons varies less than quadratically along the line, as then no extrema occur. (auth)

32472 INSTABILITIES PRODUCED IN A PLASMA BY A CURRENT FLOWING ACROSS THE CONTAINING MAGNETIC FIELD. **Aref'ev, V. I.; Gordeev, A. V.; Rudakov, L. I. (Inst. of Atomic Energy, Moscow). pp 165-80 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).**

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

An analysis is made of the conditions producing the instability of a plasma in a nonuniform magnetic field. It is shown that the current component perpendicular to the magnetic field can cause the instability. The high frequency region of unstable oscillations in which ions are not magnetized is studied. Instabilities on the electron acoustic oscillation branch, where the oscillation increments are large are discussed. A nonlinear theory is derived for this instability and the rate of ion heating due to Cherenkov absorption of the unstable oscillations is calculated. The theory is found to be in good agreement with the results of experimental heating of a plasma by magneto-acoustic and ion-cyclotron waves. The instabilities that can develop at the front of a straight magneto-acoustic shock wave as it is being formed in a dilute plasma are considered. It is shown that a wave front with a width δ less then c/ω_{pi} is unstable with respect to "whistling atmospherics" perturbations of the order δ. These instabilities develop within a time less than the "steepening" time of a nonlinear magnetoacoustic wave and should hinder the formation of a wave front with a width less than c/ω_{pi}. Finally the high-frequency instabilities that can develop in a thin-skinned paramagnetic pinch are considered. The occurrence of a force-free paramagnetic pinch and of energetic ions in experiments carried out in devices of the Zeta type are discussed. (auth)

32473 MHD STABILITY OF A ROTATING PLASMA SURROUNDED BY A NEUTRAL GAS. **Minardi, E.; Terlouw, J. C. (EURATOM-FOM, Jutphaas, Netherlands). pp 97-111 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.**

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

A theoretical study is made of the MHD stability of a rotating plasma column with a cold gas blanket. The model is a rotating system formed by an infinitely conducting, incompressible plasma, confined by a B_z field and an external B_θ field and by an adiabatically compressible neutral gas. The system is rotating with constant angular velocity inside a rigid conducting vessel. An infinitely thin transition layer carrying axial and azimuthal currents separates the plasma from the neutral gas and acts as a discontinuous surface for the density and for the temperature. At equilibrium the latter is assumed constant in the neutral gas. Oscillation modes are found that are related to the presence of the neutral gas and to the rotation. Indeed, standing waves can be excited in the annular region between the plasma and the wall. In the frequency domain $\omega > kv_s$ (v_s sound velocity, k axial wave number) the modes only exist if compressibility of the neutral gas is taken into account. Incompressional modes merely can be excited for $|\omega^+ mW| < |2W|$ where W is the angular velocity and m labels the azimuthal modes. The dispersion relation is discussed both with analytical and numerical methods in a large range of the physical parameters. The system is found to be stable in the domain of validity of the linear theory used. (auth)

32474 EFFECT OF SHEAR AND CONNECTION LENGTH ON DRIFT WAVES AND PLASMA CONFINEMENT. **Chen, F. F.; Mosher, D.; Rogers, K. C. (Princeton Univ., N. J.). pp 625-40 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.**

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The effectiveness of shear and of short connection length on drift instabilities in a 0.22-eV thermally ionized, 3-meter-long potassium plasma was investigated. These experiments were carried out with T_i/T_e and ρ_i/R in a regime comparable to what would obtain in a fusion reactor. In the density range $n = 10^9$ to 10^{11} cm^{-3}, the transition from collisionless to collisional excitation of drift waves is covered. By tailoring the radial electric field, it is possible to produce quiescence, turbulence, or single modes. Shear is applied by passing current through a 1-cm-diam hard core along the axis. Both turbulent and coherent drift waves are stabilized by shear of order $\theta \sim 0.05$, in fair agreement with the theory of Krall and Rosenbluth. However, at large shear, small-amplitude coherent oscillations reappear unexpectedly. At zero shear, $D_\perp$ is 2 to 3 times the Bohm diffusion coefficient; at maximum shear, $D_\perp$ is decreased a factor of 5 to 30 to 2 to 3 times the classical value. At least half of $D_\perp$, however, is not connected with oscillations at all; it is due to the dc drifts in weak asymmetric electric fields produced by temperature variations at the end plate. The twisting of the equipotentials into spirals, and thus symmetrization of the E fields, has been observed in detail experimentally. A finite-Larmor-radius theory for the effect of shear in reducing the radial drift is found to be in agreement with the observed reduction in $D_\perp$. Short connection length is achieved by internal current loops providing a B_z opposing the main B_z, thus creating stagnation points lying on the axis. In the vicinity of each ring, the plasma is bent around the ring and is stabilized by both minimum-$\bar{B}$ and viscous damping. The rings are spaced 75 to 180 cm apart, and between rings the field is uniform. Thus, instabilities are restricted to those with short $\lambda_\parallel$. One finds that the oscillation level is greatly reduced by current in the rings. It is concluded that (1) radial electric fields affect not only the frequencies but also the excitation thresholds of drift waves, (2) it is easy, with small shear or minimum-$\bar{B}$, to reduce oscillations to a level at which they contribute negligibly to anomalous transport; and (3) the primary loss mechanism is steady convection along asymmetric equipotentials, and large shear can reduce the loss rate by twisting the equipotentials into long spirals. (auth)

32475 EXPERIMENTAL STUDY OF THE EFFECT OF RADIAL ELECTRIC FIELDS ON THE STABILITY OF A MAGNETICALLY CONFINED PLASMA. **Enriques, L.; Levine, A. M.; Righetti, G. B. (EURATOM-CNEN, Rome). pp 641-7 of Plasma Physics**

and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd 'nternational Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Low-frequency, spontaneous, electrostatic oscillations propagating azimuthally in low-β, magnetically confined plasma columns, have been studied in many devices. In most of these experiments, the peak amplitude of the observed oscillations has been in a region where both radial density gradients and radial electric fields existed. To separate these two effects, the behavior of the coherent oscillations of an alkali plasma was studied in conditions where the radial electric field could be externally controlled. The experiments were performed in a single-ended, large-diameter (8 cm), alkali plasma (Q-machine). To achieve an adjustable electric field, the hot end plate was split into two concentric parts separated by a small gap. By applying a steady voltage between these sections, an adjustable electric field is observed down the 90-cm length of the plasma column. For low applied voltages the plasma was quiescent. When the voltage was increased above a threshold value (between 0.05 and 0.5 V), low-frequency (1 to 10 kHz) coherent oscillations were observed. In this case, the electric-field drift velocity was much greater than the density-gradient drift velocity. The oscillations propagated azimuthally in the $\vec{E} \times \vec{B}$ direction and formed a standing wave in the radial direction. For a given azimuthal mode number, the frequency was proportional to the applied voltage. Potential and density fluctuations were out of phase, suggesting that this is a flute-type mode, perhaps driven by shear in azimuthal velocity. At higher applied voltages (1 to 3 V), the density gradient in the center part of the plasma increased noticeably. In this region there was a strong density gradient, but a comparatively small electric field. Here, a different kind of azimuthally propagating, coherent, low-frequency (1 to 3 kHz) oscillation was observed. In this case, density and potential oscillations were in phase, suggesting some form of drift wave. (auth)

32476 LOW-FREQUENCY STABILITY OF AXISYMMETRIC TORUSES. Rutherford, P.; Rosenbluth, M.; Horton, W.; Frieman, E.; Coppi, B. (Princeton Univ., N. J.). pp 367-87 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The low-frequency stability of low-β collisionless plasma in axisymmetric toroidal configurations such as multipoles with and without applied toroidal fields was studied in some detail. Defining the "bounce" frequency $\omega_b = (\int dl/v_{||})^{-1}$ modes are investigated with $\omega > \omega_{be}$, $\omega_{bi} < \omega < \omega_{be}$, and $\omega < \omega_{bi}$. Three classes are found: (1) flute modes, (2) ballooning and drift modes, and (3) trapped particle modes. Stability of the flutes requires, without a toroidal field, favorable $\int dl/B$, and with a toroidal field a new generalization of the V'' criterion. Even with these criteria satisfied, residual flute instabilities occur, depending on resonant particle effects. Two modes are found: an electron flute with $\omega/\omega_{be} > 0$ destabilized if $\omega_{bi} < \omega < \omega_{be}$ by electron resonances provided $T_i/T_e < L^2/r\bar{R}$, and an ion flute with $\omega/\omega_{bi} > 0$ destabilized if $\omega \lesssim \omega_{bi}$ by ion resonances requiring finite Debye length and $k_\perp^2\lambda_{Di}^2 > (1 + T_e/T_i)r/\bar{R}$, though having an exponentially small growth rate if $(1 + T_e/T_i)\, 4\pi\rho c^2/B^2 > r\bar{R}/L^2$. Here $\omega_{i,e}$ are the diamagnetic drift frequencies, r the density scale length, R the average radius of curvature, and L the connection length. For systems unstable to the generalized V'' criteron, the residual ion stability occurs at all densities and is insensitive to shear. Slight anisotropy or temperature gradient also affects the stability of the residual ion flute, but quasi-linear calculations indicate that the nonlinear formation of a sufficient stabilizing anisotropy is slow. The drift ballooning mode local to a bad curvature region and the drift universal mode are unstable for $\omega_{bi} < \omega < \omega_{be}$ provided $T_i/T_e < L^2/rR$ and $T_i/T_e < L/r$, respectively. An eikonal procedure provides the effect of shear on the ballooning mode including geodesic curvature. Trapped particle models have $\omega < \omega_{bi}$. Curvature-driven modes, insensitive to shear but stable in maximum-J configurations, are also stabilized if r/R is not too small, and criteria are given but can be very restrictive. For large $k_\perp$ a new overstable mode relatively insensitive to shear, independent of curvature, and not involving resonant particles is found, requiring terms of order $(\omega/\omega_{bi})^2$ and $k_\perp^2 a_i^2$, where a_i is the ion Larmor radius: instability occurs if $k_\perp^2 a_i^2 > (1 + T_i/T_e)r/L$. (auth)

32477 PLASMA INSTABILITIES IN GULF GENERAL ATOMIC MULTIPOLE DEVICES. Ohkawa, T.; Yoshikawa, M.; Schupp, A. A. (Gulf General Atomic Inc., San Diego, Calif.). pp 329-38 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Plasma instabilities were studied in both the octopole and quadrupole configurations. A typical set of parameters is a plasma density of 10^{10} cm^{-3}, an ion temperature of 100 eV, and an electron temperature of 10 eV. In both devices, the difference of the vector potential between the separatrix and the wall or the stability limit corresponds to about five gyroradii for 100-eV hydrogen ions. In the octopole configuration, three types of fluctuations are recognized. The first type of fluctuation has a zero wave number parallel to the magnetic field and propagates along the diamagnetic current with a wave number comparable to the reciprocal of the ion gyroradius. The amplitude of the potential fluctuation is about 50 mV and increases rapidly as the octopole field is decreased. The fluctuation is suppressed by applying a toroidal field of a few gauss or by lowering the ion temperature. The results of the fluctuation measurement and the transmission experiment agree with the theoretical dispersion relation for drift cyclotron instability. The second type is observed at the plasma density below 3×10^8 cm^{-3} with a toroidal field larger than 40 G. The mode is identified as the electron-driven drift cyclotron instability with finite parallel wave number. The third type is observed in the plasma with a density below 3×10^{-8} cm^{-3} only when the ion temperature is lowered. A toroidal field of a few gauss suppresses the fluctuation. The amplitude is approximately uniform and no phase shift is observed along the magnetic line of force. This mode is interpreted as the ion-driven instability due to the modulation of the magnetic field along the line of force. Large-amplitude (20%) fluctuations are found inside the stability limit in the quadrupole device. The frequency spectrum is 10 to 500 kHz. The wave number parallel to the magnetic field line is zero. The phase velocity is in the direction of and less than the ion diamagnetic drift velocity. These characteristics are consistent with an interchange instability due to finite gyroradius of ions. The absence of this type of instability in the octopole device is expected from the theory. (auth)

32478 TRAPPED PARTICLE INSTABILITY IN AXISYMMETRIC TOROIDAL SYSTEMS. Kent, A.; Stringer, T. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 299-309 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The trapped-particle instability of low β plasmas was studied in toroidal fields with large aspect ratio and nearly cylindrical symmetry. This problem was considered by Kadomtsev and Pogutse for Tokamak fields where the component B_θ about the minor axis is small. One finds that when B_θ is not small, as in pinch-like systems, the instability has a qualitatively different behavior. The instability arises in systems with large B_θ only if the local radial density variation at some point is much stronger than that of the magnetic field strength, and does not arise at all in a magnetic well. Shear of the magnetic field lines is not important. The presence of a radial electric field in Tokamak systems is known to change the nature of the instability, but has no effect on large B_θ system except to cause a frequency shift. Collisions have a stabilizing effect. The conclusion is that devices with large B_θ are less prone to the trapped-particle instability than Tokamaks. (auth)

32479 FACTORS INFLUENCING THE PERIOD OF IMPROVED STABILITY IN ZETA. Robinson, D. C.; King, R. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 263-76 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

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Measurements by Thomson scattering show that the electron temperature, T_e, at the start of the period is about 100 eV. Studies were also made of T_e during this period. Detailed measurements were made of the plasma parameters (N_e,T_e) at the edge of the discharge. Measurements of the axial field at a pinch parameter of 1.8 show that this field is reversed by about 20% of the initial axial field B_ϕ at the start of the period. This reversal disappears after 1 ms when the improved stability ceases. At a pinch parameter of 2.9 the reversal is 80% of B_ϕ and the period is extended to 3 ms. The degree of reversal is constant round the major axis of the torus. A reversed axial electric field at the edge of the plasma is always observed during the period. The dependence of stability

on this field was studied further by modifying the machine so that the field can be controlled externally. The observations of the field configuration in the outer regions during the period of stability are consistent with the requirements of MHD theory. However, residual fluctuations are still observed and an analysis was made of the possible instabilities which might cause these fluctuations. The MHD stability close to the magnetic axis for localized modes with vanishing pressure gradient was studied and compared with experiment. Resistive instabilities, in particular the tearing mode, and the possibility of stabilization by ion viscosity, were analyzed for the measured configurations. Growth times were estimated. The trapped particle modes were predicted not to be serious during this period and calculations were made of the shear stabilization of drift modes. (auth)

32480 PLASMA STABILITY IN CLOSED SYSTEMS. Sol-ov'ev, L. S.; Shafranov, V. D.; Yurchenko, E. I. (Moscow Inst. of Atomic Energy). pp 175-98 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The stability of closed plasma configurations was investigated, using the general geometric criterion of local stability developed by Mercier and coworkers. To render in an explicit form the equilibrium configuration parameters on which the stability of the configuration depends, the general geometric criterion is transformed by expanding with respect to the deviation from the magnetic axis. In the resulting criterion, the terms describing the ballooning mode and plasma stabilization through deepening of the magnetic well due to the toroidal magnetic surface displacement associated with the plasma pressure are rendered explicitly. For circular magnetic surface cross sections, these terms cancel out exactly and the stability condition is found to be independent of the plasma pressure. In the case of elliptical magnetic surface cross sections, the effect of the ballooning instability predominates over deepening of the magnetic well. In this case the plasma pressure, which is critical for stability, is limited. The resulting stability criterion is applied to a number of toroidal systems. The authors consider the conditions for stability in closed systems with a spatial magnetic axis and in systems with a circular magnetic axis of the two-turn and three-turn stellarator type. They also consider the effect of the longitudinal current on plasma stability in such systems. In closed magnetic traps without longitudinal current, plasma stabilization is relatively simple in the presence of a shallow magnetic well. The critical value of $\beta = 2p/B^2$ may exceed the relative depth of the vacuum magnetic well $\phi V''/V'$ by an order of magnitude. When there is a longitudinal current, there appear additional factors that affect the stable containment of the plasma. (auth)

32481 DYNAMIC STABILIZATION OF THE THETA PINCH. Wesson, J. A.; Haas, F. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 12: 1271-8(June 1969).

Previous work has shown the $\beta = 1$ theta pinch to be stable for the mode $m = 1$ and unstable for $m > 1$. It is shown that a periodic theta pinch having a radius $R(z) = R_0[1 + \delta f(z)]$, where $\delta \ll 1$, can be dynamically stabilized for $m \ll 1/\delta$. (auth)

32482 ION CYCLOTRON INSTABILITY OF ENERGETIC PLASMA CONFINED IN MAGNETIC MIRRORS IN THE MODEL C STELLARATOR. Brown, I. G.; Rothman, M. A.; Sinclair, R. M. (Princeton Univ., N. J.). Phys. Fluids, 12: 1318-28 (June 1969).

A portion of the plasma in the Model C stellarator is heated by ion cyclotron resonance heating and contained within magnetic mirrors ($1.02 \leq R \leq 1.3$, $B_0 \approx 35$ kG). The plasma so formed ($n_e \approx 10^{12}$ to 10^{13} cm^{-3}) has little interaction with the main body of toroidal plasma, and has perpendicular ion temperature up to 4 keV while the electron temperature remains at less than 100 eV. New results show that the cooling of this energetic plasma, lasting several milliseconds, is accompanied by emission of radiation at frequencies close to the local ion cyclotron frequency and its harmonics. Experimental results are presented of observations of this rf activity, and related to theoretically predicted instabilities of the ion cyclotron type. It is concluded that the observed behavior can be satisfactorily explained by the presence of an electrostatic, temperature-anisotropy-driven instability. There is no correlation between the rf activity and the cooling time of the mirror-contained plasma; the containment time still seems to be limited by charge exchange. (auth)

32483 STABILITY OF ORBITS IN COMBINED BETATRON AND AZIMUTHAL MAGNETIC FIELDS. Ferrari, Lawrence A. (Queens Coll., New York. Brookhaven National Lab., Upton, N. Y.); Zucker, Martin S. Phys. Fluids, 12: 1312-17(June 1969).

In a cylindrically symmetric magnetic field the requirement for a stable betatron orbit is that there be a minimum in the vector potential component A_θ, i.e., the induction electric field strength. The problem of stability when an azimuthal or B_θ field is added to the betatron field is considered. It is shown that when B_θ is present there must be an extremum in A_θ for stable motion. This criteria includes the pure betatron field as a special case so that the Schmidt beam current formula still applies. Schmidt's result is extended to include resistive as well as runaway currents, and its application to the various plasma betatron experiments is discussed. (auth)

32484 ELECTROSTATIC INSTABILITY IN PLASMA DUE TO AN ANISOTROPIC ION VELOCITY DISTRIBUTION. Grewal, Mahesh S. (Univ. of California, Livermore). Phys. Fluids, 12: 1259-61(June 1969).

An electrostatic instability in an infinite uniform homogeneous plasma imbedded in a uniform magnetic field is discussed. The instability is jointly driven by (a) the difference in $\theta_{\perp-i}$ and $\theta_{\|-i}$, the ion temperatures perpendicular and parallel to the applied magnetic field, and (b) the non-Maxwellian nature of the distribution of the ion velocity perpendicular to the magnetic field. The results show that for the instability to occur $\theta_{\perp-i}$ must be greater than about seven times $\theta_{\|-i}$ and the square of the ion plasma frequency must be greater than about 0.35 times the square of the ion gyrofrequency. (auth)

Thermonuclear Processes

Refer also to abstracts 31584 and 32448.

32485 (IPP-1/89) INDUCTIVE LENSES FOR IMPROVED MAGNETIC FIELD SYMMETRY IN A CORRUGATED THETA PINCH COIL. Hartz, F.; Junker, J.; Pohl, F.; Wolf, G. H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1968. 23p. Dep.

The magnetic field distribution of corrugated theta-pinch coils is measured in an analog experiment (exp. error 0.05%), in order to determine the perturbation of the rotational symmetry induced by the current feed slot. The maximum deviations from rotational symmetry are found near the coil surface around the current feed slot. They have a value of a few per cent and are proportional to the width of the current feed slot. The perturbations decrease towards the coil axis to a few tenths per cent only. The distribution of a locally varying inductance of the current transmission line is computed and applied by molding inductive lenses into the transmission line plates. The influence of the inductive lenses is measured. Within a radial region of about ½ of the coil radius, the perturbations are found to be reduced to the level of the experimental error. The residual perturbations outside this region are mainly attributed to the limited space available for the application of the inductive lenses in the transmission-line system. (auth)

32486 (NP-17893) DEVELOPING HIGH-FREQUENCY FIELDS IN PLASMA INSTALLATIONS. Zverev, G. I.; Savchenko, I. S.; Maiburov, V. B.; Lyul'ev, V. L.; Burdiashvili, M. Sh. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1969. 18p. (In Russian). Dep.

Systems designed for producing high-frequency magnetic fields of various configurations in the frequency range from 0.1 to 5 mHz are described. The fields are developed by currents in symmetrical eight-bar windings, which together with the connected capacitors, form resonance contours for powerful vacuum-tube oscillators. Data are given on the design and performance of high-frequency generators using pulsed-generator triodes of Soviet construction. (R.V.J.)

32487 (UCRL-71514) PULSE PROPERTIES OF LARGE 50-50 Ni-Fe TAPE CORES. Winter, S. D.; Kuenning, R. W.; Berg, G. G. (California Univ., Livermore. Lawrence Radiation Lab.). May 5, 1969. 18p. Dep. CFSTI.

Over 400 cores of 1-mil 50-50 NiFe, each core containing forty or more pounds of material, are used in a linear induction accelerator, which is a part of a controlled thermonuclear research experiment. Each core couples a constant voltage pulse of approximately 9 kV lasting 350 nsec to an electron beam whose current is in the hundreds-of-amperes range. To achieve reasonable operation of the accelerator it is essential that the drive power to the cores, both during the forward pulse and during reset, be kept to a minimum. Since cores of this size and constant voltage drives of this magnitude are both rarities, potential manufacturers of these cores have been reluctant to guarantee the pulse performance. To overcome this reluctance a study program consisting of both a theoretical analysis and experimental tests was conducted. Specifically, the purpose of the study was to

find answers to three key questions: 1)"What is the minimum current required in an optimum core?", 2)"What are the major contributors to deviations from the minimum current?", and 3)"What can be done to insure consistently good cores?" Results of the study for cores made of both 1-mil and ½-mil tape are discussed; the major findings being that at these drive levels, eddy currents both within individual wraps and between wraps cause the dominant losses. Recently about 200 such cores were obtained. The measured pulse values are compared with the predicted values. (auth)

32488 AN EXAMPLE OF AVERAGE MINIMUM-B FIELD PRODUCED BY SPHERICAL-COORDINATE SCALAR POTENTIAL. Itatani, Ryohei; Abe, Hirotada (Kyoto Univ). Kakuyugo Kenkyu, 22: 357-68(Apr. 1969). (In Japanese).

It is proved that some compositions of independent magnetic field scalar potentials, which are expressed by spherical coordinates, construct the toroidal closed magnetic surfaces and have characteristics of average minimum-B toroidal field. The equations of the magnetic surfaces, V', the rotational transform angle on the magnetic axis of these fields, are calculated by the method of averages. (NSA of Japan)

32489 THE ACCELERATION OF MACROPARTICLES AS A POSSIBLE WAY FOR OBTAINING THERMONUCLEAR REACTION. Bielewicz, J. (Inst. of Nuclear Research, Warsaw). Pol. Tech. J., 11: 1261-7(1967). (In Polish).

Accelerating macroparticles to velocities in the range of 10^6 to 10^8 cm would lead to a number of applications such as the simulation of meteors, the production of very dense plasmas, and possibly the release of controlled thermonuclear energy. A review of the known methods of acceleration is presented, both with respect to velocity and size of the particles, and comparison is made with the trigger criterion for very small thermonuclear explosions; none of those methods seems promising. A new method of acceleration is described. (auth) (NSA of Poland)

32490 PULSED CHARGING OF CAPACITORS BY MEANS OF EXPLODING WIRES. Liebing, L. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Angew. Phys., 26: 345-50(1969).

The estimated impedance of short-pulsed plasma accelerators intended for producing fusion energies leads to very high load voltages of a minimum order of magnitude of 300 kV, to which a fast energy storage capacitor has to be charged. Such high voltages should be produced by pulsed charging to minimize the risk of breakdown. Pulsed charging by means of intermediate inductive storage is described. The necessary switch-off procedure is done by means of an exploding wire. The voltage factor and efficiency are measured. A new two-stage inductive charging circuit for raising the voltage factor is described and tested. Some of the processes occurring on vaporization of the wire are measured. The experimental results are used to draw conclusions about larger energy-storage systems. (auth)

32491 PULSED GAS VALVE FOR FAST TIMEABLE HIGH PRESSURE OPERATION. Henins, Ivars; Marshall, John (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum., 40: 875-8 (July 1969).

A fast opening, high pressure gas valve has been developed. It is electrically timeable and can admit several hundred cubic centimeters · atm gas from a plenum of 1 to 10 cm^3 volume, initially filled at pressures up to 100 atm. The opening rate of the valve stopper is about 7 m/sec and is derived from the sudden release of the stored energy in an axially compressed nylon rod. Emptying time depends on plenum volume and is of the order of a few hundred microseconds. (auth)

32492 THEORETICAL AND EXPERIMENTAL RESULTS ON THE TRAPPING AND BEHAVIOUR OF THE E-LAYER IN THE ASTRON. Beal, J. W.; Brettschneider, M.; Christofilos, N. C.; Hester, R. E.; Lamb, W. A. S.; Sherwood, W. A.; Spoerlein, R. L.; Weiss, P. B.; Wright, R. E. (Univ. of California, Livermore). pp 967-80 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

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The injection of 300 A of 3.8-MeV electrons into the Astron solenoid has resulted in the trapping of sufficient electrons to form an E-layer with strong diamagnetic effect. Low-frequency stable precessional oscillations of the E-layer have been observed during the initial operation of the Astron facility. The precession frequency ω_p is the difference between the gyrofrequency (ω_b) and betatron frequency ω (1-n/2) of the E layer where n = (R∂B/B∂r) of the confining mirror field. The magnetic field of the E layer generates image currents in the walls of the tank, which in turn generate a field with positive gradient which is proportional to the loading factor (ξ) of the E layer (ξ is defined as the ratio of the self-field of the E layer to the external confining field B_v). When the loading factor ξ exceeds a certain threshold (ξ_c) the sense of the precession is reversed, and theory predicts that the motion is stable in agreement with the experiment. The field generated by an E layer of moderate thickness has been calculated. The image currents, the positive field index, and the threshold value of the loading factor ξ are calculated as a function of the tank wall and the E-layer radius. The image currents provide a minimum-B field which tends to center the E-layer about the axis of symmetry of the tank. The experimentally observed value of ξ exceeds the calculated threshold ξ_c but as electrons are lost by scattering in the residual gas the loading factor is gradually diminished. When ξ reaches the calculated value of ξ_c the net value of the field index becomes zero, an integral resonance occurs, and theory predicts that the E layer will be "dumped" promptly. The "dump" is experimentally observed at the calculated value of ξ_c. (auth)

32493 CONFIGURATIONS OF THE STELLARATOR TYPE WITH MEAN WELL AND SHEAR. Gourdon, C.; Marty, D.; Maschke, E. K.; Dumont, J. P. (EURATOM-CEA, Fontenay-aux-Roses, France). pp 847-61 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In French).

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The configurations studied are defined in terms of conductors and currents. The magnetic lines or trajectories are then integrated numerically by means of an IBM 360-75 computer. It is shown that it is possible to obtain simultaneously, in a magnetic configuration of the stellarator type, a mean magnetic well and substantial shear. The configuration consists of three basic fields; an azimuthal field (B_φ = const/r); a multipolar field produced by helicoidal conductors (l = order of multipolarity, m = $d\theta/d\varphi$); and a vertical correcting field (B_v). A comparison is made between configurations of the types l = 2, l = 3, l = 4, with different values of m. A typical l = 4, m = 3 configuration is presented in detail. For this configuration, the depth of the mean well is 20%, the communication length is about 20 times the plasma radius, and the shear length in the region of poor curvature is five times the plasma radius. It is shown in particular how magnetic well depth and rate of shear vary with variations in the amplitude of the vertical correcting field. The appearance of islands of surface degeneration due to the resonance of certain closed magnetic lines with perturbations of the configuration as a result of possible constructional defects is studied. The number of islands and their dimensions are related to periodicity and amplitude of the perturbations. The precession surfaces are also studied, the movement of the charged particles being calculated in the guiding-center approximation. This study will make it possible to determine the importance of the problem of trapped particles which do not execute a complete revolution. (auth)

32494 A MAXIMUM-B STELLARATOR. Fisher, S.; Grad, H.; Sone, Y.; Staples, J. (New York Univ., N. Y.). pp 899-916 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Every toroidal plasma is a hybrid combination of mirror machine and torus. Approximately half the plasma consists of trapped particles. Towards the outer edge, the population becomes almost entirely trapped (circulating particles are preferentially scraped off). A toroidal plasma in equilibrium cannot be isotropic, and towards the edge the anisotropy becomes more pronounced. In most geometries there will be holes in phase space which are qualitatively similar to a loss cone. The geometry proposed is one in which these mirror attributes are planned rather than accidental. The maximum-B criterion enjoys all known advantages of minimum-B (with respect to micro- and macrostability as well as containment) and is much more easily realized practically. In particular, it can be achieved in a torus without internal conductors. One representation is as a modification of an l = 3 Stellerator. Qualitatively, there is an outer shell which is comparable to a mirror machine, and an inner toroidal core. Compared to a mirror machine this offers the interesting possibility of cutting particle losses by a large factor in a familiar range of densities and temperatures. Compared to a stellarator, it offers the possibility of achieving mirror machine (or much better than mirror machine) parameters in a toroidal geometry. There are many mechanisms which can lead to "Bohm" diffusion including noncollective orbit drifts and lack of equilibrium as well as a

variety of different instabilities. It is known at the present time under what conditions each of these mechanisms is applicable or potentially dangerous. The outer shell of the maximum-B configuration should be free of this phenomenon as in any conventional mirror machine. The large flat field region in the center should be relatively free of all micro-instability. Containment of particles (a possible source of Bohm diffusion) is secured by the maximum-B property. Also, a stable outer shell should exert an inhibiting effect on whatever specifically toroidal ills the interior is subject to. The status of the theory of this type of geometry is discussed with regard to magnetic field configuration, orbits, equilibrium (scalar pressure and anisotropic), and a modicum of stability, primarily in a straight version. (auth)

32495 EXPERIMENTAL STUDY OF A PLASMA ACCELERATOR WITH LINEAR ELECTRODES. **Robert, E.; Reding, L. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). Rev. Gen. Elec., 77: 1019-28 (Nov. 1968). (In French).**

The speed and displacement of a plasma bar between two rails were found to be duplicatable if special precautions were taken. Under these conditions the influence of pressure and voltage on the constant asymptotic velocity of propagation of the discharge was analyzed. The corresponding arrangement can be used as a test set for measuring devices such as electromagnetic and optical probes and ultrarapid cameras. The electrical and electromagnetic probes used gave concordant values for the interpretation of the uniform discharge velocity in the major part of the accelerator and a general description of the physical process. The images obtained confirm a Hall effect and reveal the complexity of the initial process and the three-dimensional aspects of the discharge. For a given pressure the discharge velocity increases with voltage, but less than proportionally. (BBB)

32496 THEORETICAL AND EXPERIMENTAL STUDIES OF HIGH-FREQUENCY PLASMA STRUCTURES. **Consoli, T. (CEA, Saclay, France). pp 361-79 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In French).**

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192 (Vol.2); CONF-680805-(Vol.2).

High-frequency structures at the resonance $\omega_{ec} = \omega_{HF}$ in an inhomogeneous magnetic field were studied. The following points were developed theoretically: the complete (relativistic and nonlinear) analytical description of individual movement, taking into account the fact that the number of revolutions of the particles in the resonance zone is high; study of the self-consistent space-charge field, with a view to establishing the conditions necessary for the energy of the ions to be of the order of the energy gained by the electrons in the resonance zone; calculation of the self-consistent hf field in the accelerated plasma, with a view to establishing the conditions for optimum operation of the hf accelerator; the problem of the mirror losses. The experimental results were obtained with various devices constructed for the purpose of verifying the theoretical predictions. With the Circé–Pléïade, where the ionization and acceleration functions have been separated by means of ionization with a Circé device (λ = 3 cm, 300 W), the relativistic law of variation of the parallel ion energy as a function of the injected density (existence of a minimum density for the entrainment of ions) and of the applied HF power (TE_{111} cavity, 3 GHz, 700 W) was verified. With the Circé accelerator (λ = 3 cm, P = 2.5 kW, CW) it was verified that, for $n_{plasma} < n_{cutoff}$, the measured value of the parallel energy of the ions or of the fast neutrals (~1 keV) created by charge exchange with the residual gas is that predicted by the theory. It is one order of magnitude lower when $n_p > n_c$, because of the strong attenuation of the field due to the high index. With the Icare device (λ = 25 cm, P_{HF} = 1 MW for 100 μs), operating with pre-ionization by laser focalization on a solid D_2 target with an injection density always higher than the cutoff density, accelerated deuteron currents of more than 20 keV and of about 10 mA/cm^2 were obtained. Ion entrainment for a magnetic field twice that necessary for resonance was also verified. Finally, with the Pléïade I device (λ = 100 cm, P_{HF} ~ 500 W, CW), the reflection of accelerated plasma jets by a mirror pulse lasting 75 μs was verified. From measurements of the fast neutrals resulting from ion charge exchange (with the residual gas; $p \lesssim 10^{-4}$ mm Hg) it was deduced that the density of the ions (directed energy ~1.5 keV) may be increased from 2×10^9 cm^{-3} (direct beam) to 6×10^9 cm^{-3} during the mirror pulse. The accumulated density appears to be limited by the charge exchange, and the increased duration of the mirror pulse to 200 μs with $p \lesssim 10^{-4}$ mm Hg (unchanged) hardly improves the accumulation ratio. This agrees with the predictions if one takes into account the fact that the ion lifetime is ~10 μs. (auth)

32497 ON THE MECHANISM OF NEUTRON PRODUCTION FROM THE DENSE PLASMA FOCUS. **Bottoms, P. J.; Carpenter, J. P.; Mather, J. W.; Ware, K. D.; Williams, A. H. (Los Alamos Scientific Lab., N. Mex.). pp 67-75 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969.**

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It is now established that the dense plasma focus (DPF), a self-constricted plasma current discharge (z pinch), is an intense source of neutrons (10^{10}/burst). The lifetime of the plasma, measured in terms of neutron production, is ~80 to 150 ns. The DPF device consists of a 20-kV, 360-μf capacitor bank, coaxial electrodes of 15-cm-outer and 10-cm-inner diameter operating with deuterium gas pressures of 5 to 10 torr. An electron plasma temperature and density of 5 to 8 keV and ~2×10^{19}/cm^3, respectively, are typical values. The initial heating of the plasma ions is accomplished during the rapid 2-dimensional r, z compression; the fountain shape of the converging current sheath produces plasma streaming and precludes any real confinement. A study of the pulsed neutron energy spectrum by the time-of-flight technique made at angles of 0, $\pi/2$, and π radians shows that the average neutron energy is 2.77, 2.59, and 2.22 MeV, respectively. The center-of-mass velocity of the plasma source is 1.24×10^8 cm/sec. The center-of-mass motion may be explained in terms of a high-energy stream of ions striking a dense stationary plasma (target model) or by a thermal plasma which is moving along the axis (moving isotropic model). Use is made of the intense neutron production as a diagnostic tool to investigate the angular distribution of neutron production. A comparison of the experimental results with theory is inconsistent for the target model, but is consistent with the moving thermal plasma model. If one assumes that the entire hot plasma is moving at velocity v_{cm}, then a paradox exists. For example, the time duration of neutron production and the observed streaming velocity would give an apparent plasma length of some tens of centimeters; this is not observed. It is suggested that only the plasma in the early stages of compression may exhibit the observed streaming velocity, and neutron production during the pulse may not be characterized by the observed cm velocity. (auth)

32498 STEADY STATE PLASMA ACCELERATORS AND THEIR APPLICATIONS IN THERMONUCLEAR RESEARCH. **Morozov, A. I. (Inst. of Atomic Energy, Moscow). pp 3-19 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).**

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192 (Vol.2); CONF-680805-(Vol.2).

Steady-state plasma accelerators make it possible, in principle, to obtain plasma fluxes of high energy and large flow rate. This is of interest in thermonuclear research for two reasons. Firstly, the accelerator can be used for injecting plasma into existing traps; secondly, it can be used to design new types of thermonuclear reactors, which might be referred to as "flow-type reactors" in which a positive yield is realized during the time the material passes through the reactor system. The main types of accelerating mechanisms operating in this accelerator are described, and a brief review is given of theoretical, numerical, and experimental investigations carried out. The numerical and theoretical analysis of the processes taking place in coaxial steady-state accelerators revealed the possible existence of steady-state compressive flows during which the applied electromagnetic energy is not converted into kinetic plasma energy but is used for compression of the plasma. When the compressed flow is allowed to expand, its thermal energy is converted into kinetic energy. Devices in which compressive flow is attained are referred to as magnetic plasma compressors. At the present stage the existence of compressive flows has been confirmed experimentally. To ensure a positive yield in the region of compression, a density of 10^{20} to 10^{21} cm^{-3} is essential. The possibility of obtaining a positive yield in linear "flow-type reactors" is discussed. Such reactors consist of magnetic plasma guides of length ~100 m, in which a flow of hot plasma is produced by a steady-state plasma accelerator. (auth)

32499 ORNL LEVITATED TOROIDAL MULTIPOLE PROGRAM. **Roberts, M.; Alexeff, I.; Dory, R. A.; Halchin, W.; Stirling, W. L. (Oak Ridge National Lab., Tenn.). pp 351-65 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.**

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Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Confinement of gun-injected and microwave-produced plasmas in a levitated toroidal quadrupole in which internal hoop supports are not present to limit plasma confinement was studied. Electromagnetic levitation is made possible by reducing the 60-Hz skin depth in the copper walls with liquid-nitrogen cooling. The cooling also increases the magnetic field lifetime so that an e-folding time of 17 ms was measured after crowbarring. Computations indicate that, in a properly designed larger device, an e-folding time of 100 ms can be reached. Washer-gun hydrogen plasmas and Bostick-type lithium-gun plasmas were injected into the levitated quadrupole with typical parameters: $B \geq 3$ kG, $T_e \approx 3$ eV, $n_i \approx 10^9$ cm^{-3}, and $1 < T_i < 30$ eV. The hydrogen plasma lifetime increased as the probe area decreased, and extrapolated to about 30 times Bohm. The longest observed e-folding lifetime was about 1 ms. Surprisingly long-persisting localized fluctuations in the 300-kHz range appear azimuthally opposite the plasma-producing H or Li gun. Electron-cyclotron resonance (with 40 W at $\lambda = 12$ cm) was used to produce hydrogen plasmas with parameters: $n_i \approx 10^{10}$ cm^{-3}, $T_e \approx 30$ eV, and $\tau/\tau_{Bohm} \approx 30$. Density fluctuations ($\Delta n/n$) in the region of good field curvature were less than 0.05 and in the region of bad curvature 0.10 to 0.25. With the removal of the magnetic well (by removing the inner hoop), τ/τ_{Bohm} and n_i each dropped a factor of 4 and $\Delta n/n$ became greater than 0.25. Experiments using 200 W at $\lambda = 3$ cm produced plasmas with higher densities ($n > 10^{11}$ cm^{-3}, assuming $T_e \approx 100$ eV), higher temperatures ($T_e \approx 100$ eV) and longer lifetimes ($\tau \approx 80\ \mu s \approx 40\ \tau_{Bohm}$) than in the $\lambda = 12$ cm experiments. Detailed probe measurements of density and temperature are consistent with models for plasma behavior based on computed magnetic field plots. Probe data show clear evidence of the changes in heating zones during the variation of the sinusoidal magnetic field and a large obstacle intercepting all flux lines effectively prevents the formation of the plasma. A levitated helical hexapole, whose advantages over the quadrupole are a better ratio of connection length to radius of bad curvature and more confinement volume, was also studied. (auth)

32500 SURVEY ON CLOSED PLASMA SYSTEMS. Artsimovich, L. A. (Kurchatov Inst. of Atomic Energy, Moscow). pp 11-17 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Experimental studies of various closed systems over the past three years are reviewed, and accomplishments are summarized. (M.O.W.)

32501 SUMMARY REMARKS. Buchsbaum, S. J. (Sandia Corp., Albuquerque, N. Mex.). pp 19-24 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The included papers dealing with low-β systems (hf heating, acceleration and stabilization, and laser plasmas), high-β systems (plasma focus), and the Astron are summarized. (M.O.W.)

32502 ON THE CONDITION OF SELF-SUSTAINING OF NUCLEAR FUSION REACTORS. Valentini, H.-B. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Kernenergie, 12: 98-103(Mar. 1969). (In German).

A simple model of a steady-state D–D reactor is described. Favorable conditions may be obtained if one succeeds in feeding back the T and ^{3}He almost completely and simultaneously heating the fuel with high efficiency by the plasma taken out of the reactor. Moreover, the nearly complete feeding back of the tritium will essentially increase the T density in the fusion plasma obtainable by tritium breeding in the blanket of the reactor. A density vs radius plot for scaling steady-state fusion reactors is given. The maximum permissible radius of the reactor depends on the loading capacity of the reactor vessel with respect to particle and energy flux density from the fusion plasma and the shielding. The minimum radius necessary for self-sustaining of the reactor is determined by the condition that the energy losses occurring as a result of cyclotron radiation and in generation of the confining magnetic field should be small with respect to the power generated. If all the other parameters are constant, the maximum radius is inversely proportional to the square of the plasma particle density, and the minimum radius is inversely proportional to the root of the particle density. The fusion reactor may, therefore, be operated only for plasma densities lower than a critical density, and for radii higher than a critical radius. Thus, there are also upper and lower boundaries for power density and total power per unit length. (auth)

32503 PLASMA FOCUS AND THE NEUTRON EMISSION MECHANISM IN A Z-PINCH. D'yanchenko, V. F.; Imshennik, V. S. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1766-77(May 1969). (In Russian).

The two-dimensional nonstationary magnetohydrodynamic problem employed for theoretical interpretation of experiments with a noncylindrical z pinch is considered. For sake of simplicity, the only dissipative process taken into account in the equations is viscosity which yields a rough description of the thickness of the shock wave front. The main results of a numerical solution of the problem by the large-particle method are, on the one hand, elucidation of the process of formation of a plasma focus, and on the other, determination of parameters of the axial plasma jet. The calculations showed that for complete determination of the characteristics of the plasma focus it is necessary to include in the two-dimensional problem effects of finiteness of the plasma electric conductivity and of the sharp increase of inductive resistance at the moment of formation of the focus. Neutron escape from the jet region is estimated on the basis of the quantitative parameters of the axial plasma jet; this value is comparable to that of the general neutron yield in the discharge. From the viewpoint of neutron emission the axial plasma jet plays the role of a moving thermonuclear reactor, which satisfactorily simulates the properties of the experimental neutron radiation. The practically motionless plasma focus may also be an important contribution to the neutron yield. The general problem of the hydrodynamic accelerating mechanism in pinches is discussed. (auth)

Wave Phenomena

Refer also to absiract 32450.

32504 (SU-IPR-283) STUDIES OF PLASMA OSCILLATIONS. Status Report No. 33, August 1, 1968–January 31, 1969. (Stanford Univ., Calif. Inst. for Plasma Research). Feb. 1969. Contract AT(04-3)-326. 46p. Dep. CFSTI.

The activities reported include the following topics: (a) Low-frequency ion–acoustic and drift waves on the positive column in a magnetic field. An rf perturbation theory based on a self-consistent solution for the steady-state column has been derived, and is being tested experimentally. (b) Electron cyclotron echoes. The response of a magnetoplasma to short pulses at the cyclotron frequency is being studied. The detailed physical description of the phenomena involved permits the development of techniques for plasma density measurement and determination of collision data. (c) Beam/plasma interaction. The aspect of this phenomenon currently being studied is the effect on the interaction of bounded beam and plasma geometry. (d) Wave/wave interactions. The basic equations of small-signal plasma wave theory may now be considered to have been well verified experimentally, and higher-order approximations can be attempted. Work in this direction concerns the nonlinear coupling of cyclotron harmonic waves, extraordinary modes, and whistlers. (auth)

32505 ELECTROMAGNETIC WAVES RUNNING WITH LIGHT SPEED THROUGH MULTICOMPONENT PLASMAS OF ARBITRARY RATIO ω_p/ω. Luenow, W. (New Mexico State Univ., Las Cruces). Phys. Lett., 29A: 214-15(May 5, 1969).

The existence of nonlinear circularly polarized electromagnetic plane waves moving with light speed through hot collisionless multicomponent (more than one type of ion) plasmas of arbitrary ratio ω_p/ω in a constant magnetic field is pointed out. (auth)

32506 LOW-FREQUENCY WAVE MIXING IN A MAGNETO-PLASMA. Keen, B. E.; Aldridge, R. V. (Culham Lab., Abingdon, Eng.). Phys. Lett., 29A: 225-6(May 19, 1969).

Results are presented for the nonlinear mixing of an ion wave in a plasma and an externally applied electromagnetic wave. They are discussed in the light of predictions based on the two-fluid equations of a plasma. (auth)

32507 WEAK NONLINEAR HYDROMAGNETIC WAVES IN A COLD COLLISION-FREE PLASMA. Kakutani, Tsunehiko (Univ. of Newcastle-upon-Tyne, Eng.); Ono, Hiroaki. J. Phys. Soc. Jap., 26: 1305-18(May 1969).

The hydromagnetic waves with small but finite amplitude in a cold collision-free plasma are investigated by using a nonlinear perturbation method. In the lowest order of perturbation, one can show that the system of equations for the magneto-acoustic wave propagating along a "critical" direction is reduced to a simple dispersive equation similar to the Korteweg–de Vries equation, except that the third-order derivative (the dispersion term) is replaced by the fifth-order one. An extension of the problem to more

general dispersive system is also made. On the other hand, the system of equations for the Alfvén wave is reduced to a modified Korteweg–de Vries equation in the sense that the nonlinear term $f\partial f/\partial\xi$ in the Korteweg–de Vries equation is replaced by $f^2\partial f/\partial\xi$. In the case of steady propagation, this equation can be integrated to give a solution in closed form, which exhibits a solitary wave. Two kinds of solitary wave (both compressive and rarefied) are found to be possible. (auth)

32508 ELECTRON TEMPERATURE EFFECTS ON LOW-FREQUENCY OSCILLATIONS IN AN ALKALI MAGNETOPLASMA. Sisto, F.; Levine, A. M.; Magistrelli, F. (EURATOM-CNEN, Frascati, Italy). Nuovo Cim., 61B: 439-48(June 11, 1969).

The electron temperature of a large-diameter (8 cm) Q machine has been increased by a factor of 3 by electron cyclotron resonance heating. Using this technique, the effect of electron temperature on coherent flute modes driven by a strong radial electric field was studied. A strong stabilizing effect was found, as shown by the relationship between the threshold voltage required to excite the instability and the electron temperature. In fact, the threshold seems to be proportional to a positive power of temperature. (auth)

32509 PENETRATION OF HIGH-FREQUENCY ELECTROMAGNETIC WAVES INTO A SLIGHTLY IONIZED PLASMA. Maroli, C.; Pozzoli, R. (Univ. Milan, CNR Milan). Nuovo Cim., 61B: 277-89(June 11, 1969).

An asymptotic analysis of the penetration of a high-frequency wave into a slightly ionized plasma was made. The analysis is based on the set of Maxwell equations and a suitable kinetic equation for the electrons of the plasma. As required by the limiting process used, the ratio between the plasma frequency and the electron–neutral collision frequency must be of the same order of magnitude as the square root of the ratio between the electron and neutral masses. The usual formulas of Ginzburg and Gurevich are used only in the cases of stationary situations, while transient regimes on the electron momentum and energy relaxation scales are described by new equations. The penetrating electric field is always given by a WKB formula, even for plasma inhomogeneities comparable with the wavelength of the incoming electromagnetic field. (auth)

32510 PERTURBATION OF A MAGNETOSTATIC FIELD CAUSED BY WAVES IN A PLASMA. Klima, R. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 19: 803-5(1969).

High-frequency fields cause certain stresses in plasma. The time-averaged values of these stresses have been presented earlier. A collisionless, not very hot plasma was assumed, the hf field frequency was different from the cyclotron frequencies $\omega_{ci,e} = \pm eB_0/m_{i,e}c$. Here, moreover, it is assumed that the time-averaged values of all quantities depend on the x-coordinate only, the magnetostatic field is parallel to the z-axis, $B_0 = B_{0z}$. The conditions for pressure equilibrium are derived. (M.O.W.)

32511 WAVE PROPAGATION AND INSTABILITIES IN A ROTATING ANISOTROPIC PLASMA. Mattei, Giulio (Univ., Pisa, Italy). Meccanica, 3: 214-30(Dec. 1968).

The effects of a uniform rotation on the propagation of small plane and cylindrical perturbations through an anisotropic collisionless plasma are investigated. These effects are present in various ways on the well-known "hose," "mirror," and gravitational instabilities. Some remarks about stability and hydromagnetic waves in an anisotropic collisionless plasma are given. (auth)

32512 NON-LINEAR WAVE PHENOMENA IN A HIGH-TEMPERATURE PLASMA. Karplyuk, K. S.; Kolesnichenko, Ya. I.; Krivorutskii, E. N.; (and others) (Inst. of Physics, Kiev). pp 753-69 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

In most plasma experiments the nonlinear plasma properties are very pronounced — hence the interest in nonlinear plasma theory and particularly in the nonlinear theory of the interaction of waves in a plasma. The study of wave-interaction mechanisms is important from the point of view of understanding the many physical processes which occur in a high-temperature plasma (relaxation processes in an unstable plasma, propagation of collisionless shock waves, high-frequency stabilization of plasma instabilities, etc.). Two aspects of the theory of wave interaction are studied: (1) the theory of wave interaction in bounded plasma systems; and (2) the substantial change in the dispersion properties of drift oscillations in a plasma with high-frequency turbulence. In most works on the theory of wave interaction in a plasma, the calculations are based on the assumption of an unbounded plasma. In actual devices, however, the boundaries often affect wave propagation; this is reflected both in changes in the dispersion characteristics of the waves in an unbounded plasma and in the appearance of a new type of wave found only in bounded systems (surface waves). The theory of wave interaction in a bounded plasma is discussed. The method employed enables one to take into account interactions of all types of wave — both space and surface. Particular attention is paid to the procedure for deriving equations for the interacting waves. With the help of these equations the authors consider a number of concrete three-plasmon interactions. The special features of the interaction of waves in a bounded plasma are also noted. In most cases, together with the unbounded plasma approximation, works on nonlinear plasma theory resort explicitly to the assumption that the individual wave interactions are independent. This assumption is not always valid. Cases where certain wave processes have a considerable effect on others are considered. It is shown that the developed high-frequency turbulence of a plasma has a substantial effect on the spectrum and buildup of drift oscillations. Even in cases of relatively weak turbulence there is a critical turbulence energy at which the stabilization of drift, hydrodynamic, kinetic, and other instabilities becomes possible. A new class of nonlinear drift instabilities occurring in a turbulent plasma was found. (auth)

32513 NON-LINEAR INTERACTIONS OF POSITIVE AND NEGATIVE ENERGY MODES IN PLASMAS. Rosenbluth, M. N. (Princeton Univ., N. J.); Coppi, B.; Sudan, R. N. pp 771-94 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The effects of mode–mode coupling and nonlinear Landau damping on stability are studied in the usual weak turbulence approximation. It is shown that the multi-wave interaction can be explosively unstable when, for $\Sigma_{j=1}^{n}\vec{k}_j = 0$ and $\Sigma_{j=1}^{n}\omega_{kj}^{\rightarrow} = 0$, one also has $S_1 = S_2 \ldots S_n$, where $S_j = (\partial\epsilon/\partial\omega_{kj}^{\rightarrow})/|\partial\epsilon/\partial\omega_{kj}^{\rightarrow}|$, n being the number of interacting waves. Similarly, conditions under which the nonlinear Landau scattering (two-wave particle interaction) can lead to instability are derived. In the absence of a magnetic field the nonlinear Landau scattering occurs for particles of velocity $\vec{v}$ such that $\omega_{k'}^{\rightarrow} + \omega_{k''}^{\rightarrow} + (\vec{k} + \vec{k}) \cdot \vec{v} = 0$ and the corresponding instability condition is $S_{k'}^{\rightarrow}(\vec{k} + \vec{k}') \cdot \int(\partial f/\partial p)d^3 \cdot \vec{p} > 0$. For a plasma in a magnetic field, the resonance condition is $\omega_{k'}^{\rightarrow} + \omega_{k''}^{\rightarrow} = l\Omega_c$, $l\Omega_c$ being a multiple of the cyclotron frequency, considering waves with $\vec{k} \cdot \vec{B} = 0$, so that all particles are simultaneously resonant. The condition for explosive growth is $S_{k'}^{\rightarrow} = S_{k''}^{\rightarrow}$ and $(\omega_{k'}^{\rightarrow} + \omega_{k''}^{\rightarrow})$ $S_{k'}^{\rightarrow}\int(\partial f/\partial\epsilon)|V(E)|^2\,dE > 0$. Here the matrix element V(E) may be evaluated by using detailed balance with the simple process of single-particle scattering of waves. A significant example analyzed is that of a loss-cone distribution for a plasma in a magnetic field. This can have positive and negative energy modes, for which unstable three- and two-wave interactions can occur with growth rates which are appreciable for rather modest intensities. A mechanism of this type can be a possible explanation of bursts of radiation often associated with anisotropic plasmas. It is pointed out that these unstable nonlinear interactions can be found in some cases for drift waves. In general, these results suggest that the usual quasi-linear perturbation theory may need modification to acquire the proper convergence properties. (auth)

32514 WAVE PROPAGATION IN SINUSOIDALLY STRATIFIED PLASMA MEDIA. Casey, K. F. (Air Force Inst. of Tech., Dayton, Ohio); Matthes, J. R.; Yeh, C. J. Math. Phys. (N. Y.), 10: 891-7(May 1969).

The problem of the propagation of electromagnetic waves in a sinusoidally stratified plasma media is treated analytically. The propagation characteristics of TE and TM waves are determined, respectively, from the characteristic equations of the resultant Mathieu and Hill equations. Detailed dispersion characteristics of TE and TM waves in an infinite stratified plasma medium and in waveguides filled longitudinally with this stratified dispersion material are given. It is found that, although the stop-band and pass-band structures exist for the $\omega-\beta$ diagrams of both TE and TM waves, detailed dispersion properties for TE and TM waves are quite different for most frequency ranges except when $[(\omega/\omega_{p0})^2 - 1]^2 \gg \delta^2$, where ω is the frequency of the propagating waves, ω_{p0} is the average plasma frequency of the inhomogeneous plasma medium, and δ is the amplitude of the sinusoidally varying term for the electron-density profile ($0 \leq \delta \leq 1$). (auth)

32515 POLARIZATION OF OBLIQUELY REFLECTED WAVES FROM AN ISOTROPIC PLANT-STRATIFIED PLASMA.

Heading, John (University Coll. of Wales, Aberystwyth). Radio Sci., 4: 441-7(May 1969).

A recently devised realistic model of an inhomogeneous isotropic plane-stratified plasma is examined analytically when electromagnetic waves of both magnetic and electric type are incident upon the layer from below. Properties of the reflected wave are investigated so as to express the characteristics of the polarization ellipse of the incident wave. (auth)

32516 NONLINEAR LONGITUDINAL PLASMA WAVES. Chi, Lan-keh. Philadelphia, Drexel Inst. of Tech., 1968. 70p. Thesis.

A hydrodynamic approach for wave motions in a two-component warm plasma, is formulated. A Lagrangian representation of plasma flows is obtained by applying Von Mises' transformation to the electrohydrodynamic equations. The occurrence and the properties of limiting lines in plasma flows, are investigated. As an example, the development of an initial velocity perturbation in a warm electron plasma is examined. The breaking down of the nonlinear solution is explicitly indicated. Dawson's criterion for the breakdown of nonlinear oscillations in a cold, uniform plasma is extended to nonlinear wave propagations in a warm, nonuniform plasma. (Disser. Abstr.)

32517 WAVE STRUCTURE IN A PLASMA PRODUCED BY THE INJECTION OF FAST IONS. Bortnikov, A. V.; Brevnov, N. N.; Zhukovskii, V. G.; Romanovskii, M. K. (Inst. of Atomic Energy, Moscow). pp 311-17 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

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It was established in an earlier paper that, in the AS device, for injection currents from 0.1 to 0.8 mA, there occurs in the plasma an extremely abrupt increase in the amplitude of the high-frequency electric fields at the fundamental ion frequency and its harmonics. This threshold value of the mean plasma density depended on the magnetic field strength, in close accordance with the theoretical condition; when this condition is fulfilled there may develop in the plasma ion-cyclotron instability caused by the presence of a positive derivative in the transverse energy distribution function for fast ions. Experimental results obtained by measuring the wavelengths of oscillations that develop as a result of instability are presented. A conclusion regarding the wavelengths is reached by performing measurements with the help of a phase meter based on a system of antennas. It is established that for a constant injection current, the phase shifts between the antennas vary with time; this suggests that a set of oblique waves is excited in the plasma. (auth)

32518 PROPAGATION OF MAGNETOHYDRODYNAMIC WAVES IN AN INHOMOGENEOUS PLASMA. Doich, R. V. pp 181-94 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. II. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.2); CONF-680805-(Vol.2).

The possible existence of total Alfvén oscillations in inhomogeneous systems and the propagation of fast magnetoacoustic waves in one special case are studied. In plane systems and in systems with axial symmetry such Alfvén oscillations of the whole system are possible, taking place only on the magnetic surfaces and in a transverse direction. Oscillations of density are not then observed. It is shown that the occurrence of such oscillations is possible only when the magnetic field possesses a particular structure. A necessary and sufficient criterion is established for the existence of such waves. When this criterion is not satisfied, Landau and Cherenkov damping of the waves originating from the initial Alfvén perturbation of an inhomogeneous collisionless plasma occurs. The necessary and sufficient criterion for the existence of total Alfvén waves is also extended to the case where a gravitational field is present. In the case of a rectilinear current field for fast magnetoacoustic waves with axial symmetry, there is the possibility of formulating a variational principle. On the basis of this principle the propagation of such waves in a plasma is investigated. (auth)

32519 SUPPRESSION OF DRIFT WAVE IN A CESIUM PLASMA BY EXTERNALLY APPLIED ALTERNATING-CURRENT ELECTRIC FIELDS. Itatani, R. (Kyoto Univ.); Obiki, T.; Takahashi, N. pp 649-57 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

An experimental study of suppression of drift waves by superimposition of ac electric fields is reported. The experiment was carried out with a cesium plasma called TP-C machine at the Institute of Plasma Physics, Nagoya University. The plasma is about 1-m long and 2 cm in diameter. Plasma densities range from 1×10^8 to 3×10^{10} cm^{-3}, plasma temperatures from 2000 to 3000°K, and magnetic fields from 1.4 to 2.8 kG. A meshed grid, movable along the plasma column, divides the plasma into two regions; region I bounded by the ionizer plate and the grid, and region II by the grid and the end of the vacuum vessel. Movable Langmuir probes are equipped to measure plasma parameters and to pick up oscillations. Oscillations, having a fine spectrum and regarded as drift waves, of fundamental frequencies of about 10 kHz are excited spontaneously under two operating conditions of the ionizer; one is a low-power operation that yields an ion-rich sheath at the ionizer plate and another is a high-power operation that forms a nearly neutral sheath (slightly electron-rich or not). When an ac voltage of frequencies higher than those of the drift waves is applied to the grid and exceeds about a few tens of volts, the intensities of the waves decrease more than 20 db and their frequencies shift slightly with the increase in the applied voltage in both cases, and this suppression effect is more drastic in region II. In the case of the dc bias, according to the sheath condition, ion-rich or nearly neutral, the positive or negative bias of the grid is effective to stabilize the waves. The plasma length affects such stabilizations only in the case of the high-power operation. The stabilizing effect of the ac voltage is more efficient than that of the dc bias, although both the effects seem qualitatively equivalent. This surplus effect of the ac voltage for stabilizations may be due to the asynchronous quenching phenomenon as a result of nonlinear interactions of the drift waves with the induced perturbations like the ion acoustic waves excited by the grid. (auth)

32520 ION ACOUSTIC WAVES IN ALKALI MAGNETO-PLASMA. Doucet, H. J.; Gresillon, D. (Ecole Polytechnique, Paris). pp 659-70 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In French).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

By a series of experiments on ion wave propagation in a magnetoplasma of cesium ionized by surface ionization, the effects due to collisions between ions and neutral particles, the mean plasma velocity, the ratio $\theta = T_e/T_i$ of electron and ion temperatures, and the nonlinear behavior of a collisionless plasma were studied. In a machine called OPS using direct injection of cesium illuminating one emitter the effect of collisions between neutrals and ions has been studied. The ratio $\theta = T_e/T_i$ of the electron and ion temperatures which is an important parameter for the propagation and damping of the ion waves can be easily modified by injection of helium into the machine. The variations of phase velocity and damping as functions of the frequency for different pressures of injected neutral gas show a change in the ion temperature, the mean plasma velocity and a continuous transition from the Landau damping to the collisional damping. A separation of the two zones, the first one where the ions are cooled and the other where the wave is propagating, allows the study of the Landau damping and the measurement of the ratio θ. A nonlinear damping of the ion wave has been observed and studied. The classical Landau damping is found for the lower-frequency range, but as the distance of propagation is of the order of or larger than half a wavelength, the measured damping becomes less than the Landau damping rate, and amplitude modulation is observed. The pseudo-wavelength and the modulation rate are bound by the period and amplitude of the wave as is foreseen by a nonlinear theory. One observes that the wave behavior is similar to the effect obtained in mixing the ion wave and a fast wave which has been found in the experiments. (auth)

32521 NON-LINEAR DRIFT WAVES IN A PLASMA WITH A TEMPERATURE GRADIENT. Oraevskii, V. N.; Tasso, H.; Wobig, H. (Institut fuer Plasmaphysik, Garching, Ger.). pp 671-4 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

In a low-β plasma slab, stationary drift waves with an electrostatic potential of the type $\varphi(y-ut,x,z)$, where x is the co-ordinate in the direction of the equilibrium gradients, and z is the co-ordinate along the magnetic field, are studied. One assumes the x dependence of the varying quantities to be small, the ion tem-

perature to be much smaller than the electron temperature, and makes use of the two-fluid theory neglecting the dissipative effects. The electron temperature gradient is taken into account along with the dispersive effects due to the ion inertia perpendicular to $\vec{B}$. The final equation is similar to the Korteweg–de Vries equation. It has as solutions a general nonlinear wave, a solitary wave, and an exact sinus wave. The two last solutions are due to the temperature gradient. In the dissipative case, resistivity alone does not allow periodic solutions if solutions of the type $\varphi(y\text{-}ut + \alpha z)$ are considered. The x dependence of potential and density fluctuations seems to be essential for the calculation of the diffusion averaged over one period of oscillation. (auth)

32522 THEORY AND MEASUREMENT OF THE PERTURBATION IN THE ELECTRON VELOCITY DISTRIBUTION CAUSED BY A LANDAU DAMPED WAVE. Malmberg, J. H. (Gulf General Atomic Inc., San Diego, Calif.); Jensen, T. H.; O'Neil, T. M. pp 683-94 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The Landau damping of an electron plasma wave in a collisionless plasma produces a perturbation in the electron velocity distribution function. The first-order theory of Landau predicts persistent high-frequency oscillations in the distribution function, but no change in the time-averaged distribution. Using a procedure analogous to quasi-linear theory this calculation was carried to one higher order in the amplitude of the electric field and the perturbation was obtained in the time-averaged distribution function. The perturbation is proportional to the square of the electric field and is resonant near the phase velocity of the wave. This theory was tested experimentally by direct measurement of the time-averaged perturbation in the electron velocity distribution. Prior experiments testing the linear and nonlinear theory of plasma waves, using the same plasma, provide detailed evidence that the plasma matches the assumptions of the theory. For this experiment, a Landau damped wave is launched in the plasma and electrons near the resonant velocity are allowed to escape from the plasma. Their velocity distribution is measured with an electrostatic analyzer. The results agree with theory. (auth)

32523 NON-LINEAR PROCESSES. Cano, R.; Etievant, C.; Fidone, I.; Laval, G.; Olivain, J.; Pellat, R.; Perulli, M.; Zanfagna, B. (EURATOM-CEA, Fontenay-aux-Roses, France). pp 695-713 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In French).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The experiments described show that there are two types of nonlinear three-wave processes: (A). Disintegration of an electron plasma wave. In a plasma column of a density of 10^9 to 10^{10} electrons/cm^3, an electron temperature of the order of several eV, a length of 60 cm, a radius of 1 cm, which is confined by a magnetic field of 2500 G, a monochromatic electron plasma wave of frequency f_1 is excited. A noise spectrum in a frequency band always below f_1, due to the disintegration of this wave is observed. The resonance relations are verified. The threshold level and the energy transfer lengths are measured. The results of measurement show that the mechanism of disintegration should be interpreted without making use of the random-phase hypothesis. The shape of the spectrum is explained by varying the interaction coefficient as a function of the different phase velocities. In the same way, the parameter amplification of a wave pre-excited at one of the disintegration spectrum frequencies is studied. (B). Nonlinear generation of an electromagnetic wave. In a plasma with an electron density between 10^9 and 10^{11} electrons/cm^3, which is confined by a magnetic field of the order of 4000 G and generated by a stationary high-frequency discharge, the interaction of two microwave beams propagated perpendicularly to the confining magnetic field and polarized both according to ordinary and extraordinary modes is brought about. The interaction of these beams defines the volume of interaction in which the third wave is generated. Two processes were studied, depending on the polarization of the two primary waves: (OX,O′) and (OO′,X). The measurements show that the conditions of resonance imposed on the frequencies and propagation vectors are satisfied. The power released is compared with the theoretical value. The polarization of the generated wave is in accordance with that expected from the structure of the interaction matrix. (auth)

32524 SOME INVESTIGATIONS OF NON-LINEAR PLASMA BEHAVIOUR ON ONE-DIMENSIONAL PLASMA MODELS. Dawson, J. M. (Princeton Univ., N. J.); Hsi, C. G.; Shanny, R. pp 735-51 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Earlier calculations on the two-stream instability, using the sheet model, are extended. Vortexes in phase space similar to those found by Roberts and Berk are found. A new finite-size particle model is developed to reduce collisional effects. This model suppresses the short-wavelength field fluctuations while leaving the long-wavelength collective modes unaffected. The turbulence generated by a small bump in the tail of the distribution function is investigated on this model. It is found here as in the sheet model calculations that a hot Maxwellian tail is formed which co-exists with the main plasma for a very long time. (auth)

32525 FLUCTUATION DISPERSION RELATION DEDUCED FROM CORRELATION FUNCTION MEASUREMENTS: CHARACTERISTICS OF THE TURBULENT DIFFUSION OF A HYDROGEN PLASMA. Bernard, M.; Briffod, G.; Frank, R.; Gregoire, M.; Weisse, J. (CEN, Saclay, France). pp 715-33 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In French).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The fluctuations present in the plasma column obtained by diffusion in the DAPHNIS experiment are characterized by a continuous frequency spectrum similar to a noise spectrum whose cutoff frequency is much lower than the gyromagnetic frequency of the ions. To identify the instabilities causing these fluctuations, and to determine their role in the turbulent diffusion of the plasma, one has to use correlation methods. Correlation functions of the type $C_{xy}(\tau,r,\theta,z) = 1/T \int_0^T X(t,0,0,0)Y(t+\tau,r,\theta,z)dt$, where x and y may be, respectively, the fluctuating density, the fluctuating floating potential, or the fluctuating field were measured. From a knowledge of these functions it is possible to deduce: (a) correlation times τ_c and lengths l_c, which are quantities characteristic of the turbulence; (b) the energy spectrum of the fluctuations; (c) the experimental dispersion relation of the instabilities; and (d) the values of the fluxes $\langle nv_r \rangle = \langle n(E_\theta/B_\theta) \rangle$ indicating turbulent diffusion. Examination of the dispersion relations reveals a number of points that are in agreement with the theory of drift instabilities. In particular, propagation is essentially azimuthal ($k_\perp/k_\parallel \gg 1$) and the dependence $\omega(k)$ is linear, corresponding to a phase velocity of the same order of magnitude as the electron drift velocities. It should also be noted that most of the energy of the fluctuations is localized in the modes m = 1, 2, 3 and that increases in the applied magnetic field transfer this energy to modes of an increasingly high order. The values of the fluxes $\langle n(E_\theta/B_\theta) \rangle$ have to be compared with values which were obtained earlier by average measurements of density gradient and flux (by means of Langmuir probes and plasma eaters); these indicated diffusion ten times less than Bohm diffusion. The diffusion coefficients deduced from the correlation times, $D_\perp = \langle E_\theta^2 \rangle \tau_c / B_\theta^2$, are also compared with those obtained earlier. These results are extended to higher magnetic field and density values, and studying the effect of magnetic shear on the reduction of these fluctuations and the resulting turbulent diffusion. (auth)

32526 FINITE ION LARMOR RADIUS AND ION–ION COLLISION EFFECTS ON EQUILIBRIUM, CRITICAL FLUCTUATION, AND DRIFT-WAVE STATES OF ALKALI-METAL PLASMAS. Chu, T. K.; Hendel, H. W.; Motley, R. W.; Perkins, F.; Politzer, P. A.; Stix, T. H.; von Goeler, S. (Princeton Univ., N. J.). pp 611-24 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

Recent experiments and theories show that the effects of finite Larmor radius and ion–ion collisions, i.e., ion transverse viscosity, play a major role in determining the equilibrium state, and the linear stabilization and nonlinear amplitude saturation of the collisional drift-wave state in alkali-metal plasmas. While the Q machine is one of the most elementary devices used in plasma research, nevertheless diffusion of plasma from this device is still incompletely understood. In confirmation of the equilibrium model, which is based on the balance of end-wall recombination and electron flow, are measurements at high density, $n_i > 10^{11}$ cm^{-3}: (a) the observed variation of density with input atom flux ($n_i^2 \sim \phi$), and (b) the chopped-input measurements of plasma lifetime, $\tau(\tau = 1/\alpha_w n_i$, $\alpha_w \equiv$ wall recombination coefficient). Paradoxical are the observations that (a) $\tau \approx$ constant

for $n_i < 10^{11}$ cm^{-3}; (b) the radial loss to an absorber placed many density-profile decay lengths, l, away from the plasma axis can be 30 to 50% of the total loss; (c) l does not vary with temperature as expected ($l^2 \neq D/\alpha_{rr}n_i$); and (d) l lies in the range of 1 to 2 times the ion Larmor radius. In progress is an experimental program to reduce plasma convection due to end-plate temperature gradients, and a theoretical program in which transverse ion viscosity effects are included in the diffusion calculation. Results from this program will be related to the phenomena cited above. Detailed observations of collisional drift-waves in alkali-metal plasmas have confirmed the parametric dependence of ω and $\vec{k}$ on magnetic field strength and plasma temperature. Furthermore, the wave amplitude is observed to vary with mode number, magnetic field strength, plasma temperature and density, and ion mass as does the calculated linear-theory growth rate, provided ion transverse viscosity is included in the theory. Nonlinear theory predicts limit cycle behavior (amplitude saturation) and wave-induced transport in qualitative agreement with experimental observations. Critical fluctuations, from the critical magnetic field B_c of onset to $B \lesssim B_c/2$, i.e., in the stable regime, are identified by: (a) the presence of enhanced thermal fluctuations at the drift-wave eigenfrequency; (b) the dependence of fluctuation amplitude on calculated linear growth rate γ as a function of both B and radial position; and (c) the dependence of fluctuation amplitude on the noise amplitude, $A \propto A_{noise}$, when the noise is varied externally. Amplitudes of critical fluctuations in the stable regime and finite drift-wave amplitudes after onset agree with an amplitude master-equation of the Landau–Kadomtsev type, $\partial A/\partial t = 0 = \lambda A + CA_{noise} - \alpha A^3$. (auth)

32527 SPECTRUM OF TURBULENT FLUCTUATIONS OF PLASMA PARAMETERS IN A HIGH-CURRENT TOROIDAL DISCHARGE. Larionov, M. M.; Rodichkin, V. A.; Pozhdestvenskii, V. V.; Timonin, A. M. (Leningrad Inst. of Physics and Tech.). pp 225-35 of Plasma Physics and Controlled Nuclear Fusion Research. Vol. I. Vienna, International Atomic Energy Agency, 1969. (In Russian).

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR. See STI/PUB-192(Vol.1); CONF-680805-(Vol.1).

The turbulent fluctuations of various plasma parameters were investigated in a high-current toroidal discharge stabilized by a weak longitudinal magnetic field (the "Alpha" device). Voltage fluctuations at double probes, fluctuations in the signals from magnetic probes, and fluctuations in the power of a microwave signal in the 4-mm range passing through the plasma were studied. Using equipment for the correlation analysis of electrical signals, mean squares of the amplitudes and the power spectra of the above fluctuations over the range 50 kc to 2 Mc were determined. In addition, the spatial correlation of the signals from the double and magnetic probes were investigated. It was established that the power density of the fluctuations of all the signals in the range considered falls monotonically as the frequency rises. No characteristic frequencies are found in the spectra. It may be assumed that the voltage fluctuations at the double probes are associated with random movement of the plasma surrounding the probes across the lines of force of the magnetic field. It is then possible to calculate from the voltage fluctuations the characteristic velocity of such motion; this is found to be of the order of 10^6 cm/s. On this assumption, the voltage fluctuation spectrum coincides with the velocity spectrum of the transverse plasma motion; it is found that the velocity spectrum of the plasma motion is similar to the velocity spectrum of hydrodynamic turbulence. Velocity fluctuations in the presence of a mean density gradient lead to plasma density fluctuations. Study of the fluctuations of the microwave signal passing through the plasma confirms the presence of density fluctuations of the order of 10% of the mean density value. The turbulent motion across the magnetic field also leads to an increase in the plasma diffusion rate. The particle lifetime calculated from the coefficient of turbulent diffusion is found to be close to the measured energy lifetime. (auth)

32528 PROPAGATION OF ION-ACOUSTIC WAVES IN A PLASMA SUBJECT TO AN AMBIPOLAR DRIFT. Aksornkitti, S.; Hsuan, H. C. S.; Lonngren, K. E. (Univ. of Iowa, Iowa City). J. Appl. Phys., 40: 2674-5(May 1969).

Ion-acoustic-wave experiments were conducted in a spherical mercury-vapor plasma. An anisotropy was observed both in phase velocity and in damping when propagating ion waves from the center of the tube to the wall or from the wall to the center. The ion waves propagated perpendicular to discharge current flow. An explanation is given. (M.O.W.)

32529 DIRECT CURRENT CONDUCTIVITY IN A MERCURY DISCHARGE. Anastassiades, A. J.; Valamontes, S. E. (Democritus Nuclear Research Center, Athens). Phys. Fluids, 12: 1329-30(June 1969).

The effect on the direct-current conductivity, and electron temperature of ion-acoustic oscillations in a mercury discharge was studied experimentally. The waves were spontaneously excited in the discharge. (auth)

32530 TEMPORAL ECHOES IN COLLISION-FREE PLASMAS IN A MAGNETIC FIELD. Porkolab, Miklos (Princeton Univ., N. J.). Phys. Fluids, 12: 1330-2(June 1969).

It is shown that in a magnetic field the frequency spectrum of temporal echoes is shifted by harmonics of the cyclotron frequency even though the echo times are unaffected. (auth)

32531 WAVES AND INSTABILITIES IN A FINITE PLASMA. Cheng, C. C. (Univ. of Tennessee, Knoxville); Harris, E. G. Phys. Fluids, 12: 1262-70(June 1969).

A dispersion relation is derived for electrostatic waves in a plasma confined between planes which perfectly reflect the particles but have no effect on the fields. A uniform magnetic field perpendicular to the planes is assumed. Both classical and quantum-mechanical derivations are given. In the quantum-mechanical derivation some terms appear which do not appear in the classical derivation. These terms are due to finite de Broglie wavelength of the particles. The classical dispersion relation is applied to the investigation of volume and surface plasma oscillations and volume and surface ion sound waves in an unmagnetized plasma and to volume waves in magnetized plasmas. Volume waves are characterized by a discrete set of parallel wavenumbers. The damping or growth of volume waves is nearly the same as that of a corresponding infinite plasma wave. The damping of surface waves is quite different. (auth)

32532 INTERACTION OF MAGNETOACOUSTIC AND ENTROPY WAVES WITH NORMAL MAGNETOHYDRODYNAMIC SHOCK WAVES. Westphal, K. O. (Ames Research Center, Moffett Field, Calif.); McKenzie, J. F. Phys. Fluids, 12: 1228-36(June 1969).

Equations are obtained from which the amplitudes of magnetoacoustic and entropy waves diverging from a normal magnetohydrodynamic shock as a result of an incident disturbance of the same kind can be computed, where one assumes that the magnetic field is parallel to the flow. The solutions of these equations are then used to construct the ratios of the amplitudes of the transmitted to the incident waves. Also, the ratios of energy fluxes associated with the incident and transmitted waves are obtained in terms of the solutions of the governing equations. The formulas are applied to an example. (auth)

32533 OBLIQUE HYDROMAGNETIC WAVES IN A COLD PLASMA. Mizutani, Akira; Taniuti, Tosiya (Nagoya Univ., Japan). Phys. Fluids, 12: 1167-72(June 1969).

Steady, one-dimensional, oblique, hydromagnetic waves of small but finite amplitudes in a cold plasma are considered. Analysis is based on an equation derived by Saffman and is restricted to a class of the waves with a large critical Mach number and high-frequency oscillations. Solutions are given in an asymptotic expansion. In the lowest order of perturbation the equation is integrated to give the solutions in closed form, which exhibit compressional solitary waves. (auth)

32534 ACOUSTIC WAVE PROPAGATION IN A GAS DISCHARGE. Schulz, Michael (Bell Telephone Labs., Murray Hill, N. J.); Ingard, Uno. Phys. Fluids, 12: 1237-45(June 1969).

When ordinary sound propagates in a weakly ionized gas, the wave motion of neutral particles controls that of charge carriers. The ion-density, electric-field, and electron-temperature responses to a given gas-density perturbation are calculated by means of linearized hydrodynamic equations for the case of wave propagation along the axis of a discharge. The equations include ionizing collisions, ambipolar diffusion, wall recombination, and collisions leading to intercomponent momentum and energy transfer. Because of competing effects of ions and electrons, no observable wave amplification can result from intercomponent momentum transfer. In addition to previously reported consequences of elastic collisions, the calculated dispersion relation contains an amplification term characterized by a time constant τ_p which is approximately the reciprocal ionization frequency (per electron) times the gas-to-plasma pressure ratio. (auth)

32535 PROPERTY OF LARGE-AMPLITUDE STEADY ELECTROSTATIC WAVES. Valeo, E. J.; Oberman, C.; Kruskal, M. D. (Princeton Univ., N. J.). Phys. Fluids, 12: 1246(June 1969).

It is shown that the large-amplitude electrostatic waves of Bernstein, Greene, and Kruskal cannot be constructed from distribution functions which are monotonically decreasing functions of the particle energy. (auth)

32536 PARAMETRIC AMPLIFICATION IN PLASMAS WITH NEGATIVE ENERGY WAVES. Goldman, R. (Univ. of Maryland, College Park); Davidson, R.; Hasegawa, A. Phys. Fluids, 12: 1247-50(June 1969).

Parametric amplification is considered for systems including negative energy waves. The results may differ qualitatively from those found without negative energy waves. In particular, it is possible to excite anti-Stokes' modes in the absence of Stokes' modes. (auth)

32537 PARAMETRIC EXCITATION IN A PLASMA SLAB. Goldman, Robert (Univ. of Maryland, College Park). Phys. Fluids, 12: 1251-9(June 1969).

The theory of parametric excitation involving Langmuir and ion-acoustic waves for a homogeneous, plasma slab with specular reflection of particles at the slab walls is treated. Optimum thresholds are determined for one or two traveling waves incident on the plasma. In terms of electric fields within the plasma they are asymptotically the same as those previously calculated for infinite geometry; in terms of electric fields outside the plasma they may be much smaller. Two nonoptimum cases are also investigated. The first involves two incident traveling waves either of which by itself would produce an optimum threshold. The second consists of a single incident traveling wave which excites an infinite number of pump modes of the same size (in an asymptotic sense) within the plasma. (auth)

32538 SIMPLE WAVES IN THE KINETICS OF A RAREFIED PLASMA. Gurevich, A. V.; Pitaevskii, L. P. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz., 56: 1778-81(May 1969). (In Russian).

A general class of nonstationary solutions in which the distribution function depends only on the velocity and electric field potential is derived on the basis of self-similar solutions of the kinetic equation for a collisionless quasi-neutral plasma obtained earlier. The solutions are similar to the Riemann solution for simple waves in ordinary hydrodynamics. (auth)

32539 DYNAMICS OF A PLASMA IN A STRONG HIGH FREQUENCY FIELD. Gorbunov, L. M. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1693-9(May 1969). (In Russian).

Two nonlinear problems of the motion of a transparent plasma layer in the field of a traveling electromagnetic wave of sufficiently large amplitude (spreading out, acceleration, and compression of the layer) are studied in the quasi-static approximation. (auth)

32540 ACOUSTIC OSCILLATIONS AND THE KINETICS OF HEATING OF AN HELIUM PLASMA AT LOW TEMPERATURES. Fugol, I. Ya.; Reznikov, G. P.; Shevchenko, Yu. F. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 56: 1533-45(May 1969). (In Russian).

The low-frequency oscillations of the intensity of the radiation from a helium plasma due to cooling of the discharge tube walls by liquid helium are investigated experimentally. The oscillations are interpreted as being a manifestation of standing sound waves produced in the plasma during high-frequency breakdown. On the basis of the measured oscillation periods, the temperature of the plasma atoms is determined as a function of excitation pulse duration for various values of the discharge current and gas density. A calculation of the electron density and kinetics of heating is performed on the basis of elementary theory. Good qualitative and satisfactory quantitative agreement between the calculations and experiment is observed. It is shown that the oscillations observed can be employed for determining the various plasma parameters. (auth)

32541 MICROWAVE PULSE AMPLIFICATION BY PLASMAS. Harp, R. S.; Smith, R. R. (California Inst. of Tech., Pasadena). Phys. Lett., 29A: 317-18(June 2, 1969).

Two- and three-pulse cyclotron echoes have previously been reported. The linear dependence of the three-pulse echo on the amplitude of the third pulse and the amplification (up to 15 dB) of the three-pulse echo by a strong third pulse are demonstrated here. (auth)

32542 OBSERVATION OF OBLIQUE ION WAVES EXCITED BY AN ION STREAM. Alikhanov, S. G.; Belan, V. G.; Kichigin, G. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett., 29A: 343-4(June 2, 1969).

The excitation of slightly turbulent oblique ion waves in a nonisothermal plasma in the absence of a magnetic field was experimentally studied, and results are presented. (auth)

32543 NEW ION–ELECTRON RESONANCES IN BOUNDED, HOT, MAGNETIZED PLASMAS. Vandenplas, P. E.; Messiaen, A. M.; Monfort, J.-L.; Papier, J. J. (Ecole Royale Militaire, Brussels). Phys. Rev. Lett., 22: 1243-5(June 9, 1969).

The present investigation of a hot (T_e and $T_i \neq 0$) magnetized plasma cylinder shows that $\vec{B}_0$ can introduce novel features in the ion thermal resonances. Furthermore, two new and strong main resonances are obtained which occur in the ion domain and are essentially due to a proper combination of T_e and B_0. These resonances of a bounded plasma are only indirectly connected to the lower and upper hybrid resonances of a infinite plasma. (auth)

32544 ALFVEN WAVES IN A NONUNIFORM RESISTIVE PLASMA. Davies, B. (Flinders Univ. of South Australia, Bedford Park). Phys. Rev. Lett., 22: 1246-7(June 9, 1969).

The propagation and attenuation of torsional Alfvén waves were investigated in a nonuniform, resistive, cylindrical plasma with conducting boundary. The nonuniformity leads to increased damping and makes it difficult to launch a pure mode. (auth)

Shielding

Refer also to abstracts 31505, 31506, 31520, 33045, and 33122.

32545 (AD–682541) AN EMPIRICAL FORMULA FOR CONCRETE SLAB PENETRATION BY PLANE PARALLEL GAMMA-RAY BEAMS. Final Report on Nuclear Radiation Shielding Studies. Thayer, G. R.; Roussin, R. W.; Chilton, A. B. (Illinois Univ., Urbana). Jan. 1968. Contract N00228-66-C-0311. 102p. (NRSS–7; USNRDL–TRC–68–51). CFSTI.

An empirical formula is developed that gives the directional distribution of exposure, due to scattered radiation, emerging from a concrete slab for a plane parallel photon beam striking it. The coefficients of the terms in the formula are determined by a least-square-fitting procedure to Monte Carlo results of Berger and Morris. A detailed comparison of integrated results of this formulation and the original data is reported. Computer programs, with illustrative sample problems, are also reported. (auth) (USGRDR)

32546 (AD–684456) THE ATTENUATION OF ^{198}Au GAMMA RAYS IN AN 11-INCH STEEL DUCT. Chapman, J. M. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Dec. 1966. 10p. (NCEL–TN–864). CFSTI.

Gamma dose-attenuation factors were measured in an 11-inch square steel duct using a ^{198}Au (0.412 MeV) source. These attenuation factors were compared with those found using ^{137}Cs (0.662 MeV) and ^{60}Co (1.25 MeV) sources. It was found that the attenuation factor for ^{198}Au was always greater than for ^{137}Cs. However, for short second legs, the attenuation factor for ^{60}Co was greater than both ^{198}Au and ^{137}Cs. The measured attenuation factors for ^{198}Au were compared with values obtained using a computer code based on the albedo concept. It was found that calculated attenuation factors are about 20% higher than measured attenuation factors. (USGRDR)

32547 (AD–685667) MONTE CARLO CALCULATION OF GAMMA-RAY PENETRATION OF RIBBED SLABS. Final Report on Nuclear Radiation Shielding Studies. Morris, Edgar E. (Illinois Univ., Urbana). Dec. 1968. Contract N00228-66-C-0311. 86p. (NRSS–8; USNRDL–TRC–68–53). CFSTI.

Data are given in the form of attenuation factors for the exposure due to gamma radiation transmitted by a ribbed slab. The ribbed slab is made of concrete and is similar to one which has been used in experimental studies conducted at the University of Illinois. The source radiation was assumed to be that of ^{60}Co with source spectrum degradation due to the self-shielding of the source. Four angles of incidence, 0, 45, 60, and 75° were considered. In addition, the effect of a beam of radiation incident with directions diverging 2.5° on either side of 45° was studied in a rather crude fashion. Attenuation factors for 1.25-MeV gamma radiation incident normally on a simulated wood floor are included in an appendix. (auth) (USGRDR)

32548 (BNWL–236(Suppl.2)) A REVISED PHOTON PROBABILITY LIBRARY FOR USE WITH ISOSHLD-III. Mansius, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

An updated photon probability library containing data for 499 isotopes was compiled for use with ISOSHLD. All isotopes in the library were tagged to indicate the reliability of the tabulated photon values. Although data for short half-life isotopes are limited, this fact is shown to be unimportant for most applications of ISOSHLD. The photon library format was revised to accommodate any number of photons for each isotope. ISOSHLD was changed to accept the new expanded library, to conserve source energy rather than number of source photons, and to print out the transformed spectra by isotope. A second RIBD

library was added for fast reactor fission-product inventory calculations. (auth)

32549 (K-Trans-52) HEAVY RESIN CONCRETE: A MATERIAL FOR RADIATION SHIELDING. Loginov, V. S.; Kashkovskaya, E. A.; Astaf'ev, N. A. Translated for Oak Ridge National Lab., Tenn., from Beton Zhelezobeton, No. 4, 20-1(1968). 8p. Dep. CFSTI.

An abstract of the original Russian article appears in NSA 23: 5447. (M.H.R.)

32550 (N-69-10232) A STUDY OF CHARGED PARTICLE MOTION IN MAGNETIC RADIATION SHIELDING FIELDS. Final Technical Report. Levine, S. H.; Lepper, R. (Northrop Corporate Labs., Hawthorne, Calif.). 1968. Contract NAS8-21048. 72p. (NASA-CR-98074; NCL-68-28-R). CFSTI.

An experimental method was effected for determining the angular flux about a point dipole magnet produced by an incident anisotropic charged-particle flux. This information will be useful in optimizing active shields with material shields. The experiment was performed with the Magnetic Shield Simulator (MAGSIM), a device used to determine the shape of shielded regions produced by externally deflecting magnets. The MAGSIM was modified to provide more accurate trajectory data for this experiment. Experimental data involved two positions of the electron gun, simulating the incident charged-particle flux from two points in space. A computer program was written to reduce the data and print out the results in a convenient format. The program consists of two parts; the first determines pertinent parameters concerning the trajectories as they score the screen and then punches the data needed as input to the next phase. This first set of calculations is made to assure the accuracy of the data before proceeding to the next part wherein the angular flux is determined. (auth) (STAR)

32551 (ORNL-TM-2520) EXAMINATION OF SEVERAL CALCULATIONAL MODELS FOR USE IN COMPUTING GAMMA-RAY PENETRATION OF STRUCTURES. Yamakoshi, Hisao (Oak Ridge National Lab., Tenn.). Mar. 7, 1969. 119p. Dep. CFSTI.

Two analytical models for treating multiple scattering of gamma radiation are utilized to predict the penetration of slabs for a slant incident monoenergetic, monodirectional source incident on lead and polyethylene slabs. Monte Carlo calculations were also performed to check the validity of these two models and to give data for the construction of response functions for transmitted dose. The first model, the so-called "extended single scattering" model treats the effect of multiple scatterings beyond the first within a barrier by applying a buildup factor to the first scatter taken to be a source. The second model is based on the idea of the successive collision model and formulations of transmitted dose and spectra for up to triple scatterings are derived. Comparison between the numerical calculation of the first model and the Monte Carlo calculation with the OGRE-P3 code shows that the first model is generally not adequate for the prediction of the transmitted gamma-ray field. Comparison between the second model and the Monte Carlo results shows fairly good agreement. (auth)

32552 REFLECTION OF ^{60}Co GAMMA RAYS FROM CONCRETE. Baran, James Andrew. Manhattan, Kan., Kansas State Univ., 1968. 243p.

Thesis.

A collimator-spectrometer system was designed, constructed, and calibrated. The differential angular-energy reflection coefficients of ^{60}Co gamma rays on concrete were measured for a variety of angular configurations. Empirical equations were determined for the differential angular reflection coefficient as a function of the total scattering angle for three incident polar angles. A general-response matrix technique was developed and justified for analyzing the experimental pulse-height distributions. A statistical analysis was made of these distributions to determine the optimum-response matrix for the data analysis. (Disser. Abstr.)

32553 ADVANTAGES OF USING A COMBINATION ELECTROMAGNETIC AND MATERIAL SHIELD. Shelton, R. D.; Stern, H. E.; Watts, J. W. (George C. Marshall Space Flight Center, Huntsville, Ala.). Nucl. Sci. Eng., 36: 304-8(June 1969).

A method for calculation of proton dose in a receiver behind a combination electromagnetic and material shield is described. Dose calculations for a typical Van Allen proton spectrum and three solar-proton-event spectra are presented. In general, the electromagnetic shield stops protons below a certain threshold energy and reduces the number and energy of protons above this energy, and material shielding is more effective against these protons of reduced energy since proton stopping power increases with decreasing energy. (auth)

32554 APPLICATIONS OF THE TRANSMISSION MATRIX METHOD TO NEUTRON AND GAMMA TRANSPORT. Boulette, Ervin Thomas. Ames, Iowa, Iowa State Univ., 1968. 78p.

Thesis.

The applicability of the transmission matrix method to neutron and gamma radiation transport is investigated. The general idea of this method is that the transmission and reflection properties of a shield can be described by matrices which give the outgoing angular and energy distributions in terms of the incoming distributions. Energy and angular distributions are calculated for homogeneous one-dimensional water, lead, and uranium slabs. In addition, energy buildup factors are calculated for these three materials. Two-layer shields made up of water and lead laminae are also investigated, and energy buildup factors versus fractional composition are calculated. The transmission of secondary gammas produced by thermal neutron capture is also investigated. The analysis involves the approximation of a secondary-gamma-distributed source by a finite number of infinite plane gamma sources. The total energy transmitted is calculated and plotted versus the number of plane sources required in the approximation. (Disser. Abstr.)

32555 SINGLE SCATTERING OF GAMMA RADIATION FROM MONOENERGETIC, PLANE ISOTROPIC SOURCES IN INFINITE AND SEMI-INFINITE MEDIA. Morris, E. E. (Univ. of Illinois, Urbana). Nucl. Eng. Design, 9: 357-62(Mar. 1969).

Integral representations are given for the energy, angular, and spatial dependence of the flux density of singly scattered gamma radiation arising from a monoenergetic, plane isotropic source embedded in an infinite medium. The integrals are evaluated in terms of elementary functions for certain special cases, the most important of which is the case of backscattering from a semi-infinite medium. (auth)

Solid-State Physics

Refer also to abstract 32943.

Radiation Effects

32556 (AD-476458) IMPURITY EFFECTS IN NEUTRON-IRRADIATED SILICON AND GERMANIUM. Final Report. Curtis, O. L. Jr.; Bass, R. F.; Germano, C. A. (Nortronics, Newbury Park, Calif. Applied Research Dept.). Nov. 1965. Contract DA-49-186-AMC-235(X). 146p. (NARD-TR-235-1; NARD-65-20-R). CFSTI.

The influence of dopant impurities and oxygen on the degradation of the electrical properties of silicon by neutrons was investigated. Arsenic, phosphorus, gallium, and boron were utilized as dopants over a wide range of carrier concentrations in material grown by different techniques. The effects of neutron irradiation on carrier lifetime, mobility, and carrier concentration were measured as a function of temperature and annealing. No dependence of the rate of lifetime degradation on impurity was observed, although some differences were seen in carrier concentration and mobility changes. (USGRDR) (auth)

32557 (CEA-CONF-1256) POSSIBILITIES AND LIMITATIONS OF ION IMPLANTATION INTO SEMICONDUCTORS. Technical Note LETI/EI-490. Glotin, Ph. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 10, 1968. 22p. (CONF-681049-1). Dep.

From Conference on Special Techniques for Semiconductors as Detectors, Ispra, Italy.

A review is presented of ion bombardment as a technique for doping semiconductors to make electronic devices. The channeling effect is discussed, and the effects of chemical impurities on the electric properties of the implanted layer are considered. The problems encountered in ion implantation can be overcome by proper crystal alignment and thermal annealing. Implantations of phosphorus ions into silicon are considered as examples. It is concluded that ion implantation is a powerful technique along with diffusion. (D.L.C.)

32558 (COO-1198-626) STAGE III ANNEALING OF ELECTRON IRRADIATED SILVER. Gordon, Alan (Illinois Univ., Urbana. Dept. of Physics. Illinois Univ., Urbana. Materials Research Lab.). June 1969. Contract AT(11-1)-1198. 172p. Dep. CFSTI.

Silver specimens of nominal 99.9999% purity were irradiated at 1.6 and 3.0 MeV below 130°K. The damage production rate was found to decrease with increasing specimen purity and no evidence of linear production was found. For high-purity silver, only a single annealing peak occurs in stage III. Within the stage III peak,

the annealing behavior is complicated. The activation energy first rises, reaching a maximum of 0.71 ± 0.02 eV, and then decreases, reaching a minimum of 0.57 ± 0.04 eV. Approximately the last 80% of stage III follows second-order kinetics, but the earliest part of the anneal does not obey simple kinetics. In the region where second-order kinetics are obeyed, the number of jumps increases by a factor of 1000. After both 1.6- and 3.0-MeV irradiation, the activation energy and pre-exponential factor associated with divacancy migration is observed near the end of stage III. Various annealing models and electron microscope evidence are considered. It is concluded that the results in silver can be best explained by the migration of vacancies, produced during the irradiation, and divacancies, formed during stage III, to immobile interstitial clusters. (auth)

32559 (NIJS-P-234) INVESTIGATION OF SURFACE PHENOMENA AND RADIATION DAMAGE INDUCED BY LOW-ENERGY ION BOMBARDMENT OF SOLIDS AND THIN FILMS. Navinsek, B. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Dec. 1968. 147p. (In Slavic). Dep.

Polycrystalline tungsten foils and vacuum-evaporated titanium, gold, silver, and tungsten thin films were used as targets. After a review of results from the literature in the first chapter, results of the investigations of surface phenomena for polycrystalline tungsten are collected in the second chapter. Sorption, penetration of ions, and sputtering of tungsten by 250- to 4000-eV Ar^+ and Kr^+ ion bombardment has been studied. Sputtering yields for primary trapped gas, trapping probability, mean ranges of ions, and saturation levels were determined. By optical and electron microscopy, surface changes of bombarded tungsten targets were studied, while radiation damage and annealing of damage was observed by transmission electron microscopy. The correlation between the thermal desorption spectra and annealing of damage was made. In the third chapter, results of investigations of electrical property changes due to ion bombardment are given. After evaporation and thermal stabilization of thin films, the electrical properties of the films were determined. The changes of electrical resistivity for titanium, gold, silver, and tungsten thin films after ion bombardment were measured for different ion energies and doses. The analysis of processes influencing resistivity changes is given. The possibility to determine sputtering yields for thin films from the resistivity changes during ion bombardment is shown. This new method for sputtering yield determination can be used for nearly all sorts of thin films. General conclusions and suggestions for further investigations are given. (auth)

32560 RECOVERY OF FAST-NEUTRON-IRRADIATED IRON AT LOW TEMPERATURES. Takamura, Saburo; Maeta, Hiroshi; Okuda, Shigeo (Japan Atomic Energy Research Inst., Ibaraki). J. Phys. Soc. Jap., 26: 1125-6(May 1969).

The isochronal annealing studies of electrical resistivity of Fe after fast neutron irradiation at liquid helium temperature were performed. Recovery spectra of annealed, cold-worked, and as-received specimens were compared. The main peak in stage I was divided into two substages and stages II and III recovery seemed to be influenced by interstitial impurities. (auth)

32561 RECOVERY OF FAST-NEUTRON-IRRADIATED COPPER AND GOLD AT LOW TEMPERATURES. Takamura, Saburo; Maeta, Hiroshi; Okuda, Shigeo (Japan Atomic Energy Research Inst., Ibaraki). J. Phys. Soc. Jap., 26: 1120-4(May 1969).

The recovery of the electrical resistivity of 99.999% purity Cu and Au and Au–0.1% Cu alloy was studied after fast neutron irradiation at liquid He temperature. The damage production rate decreased by cold work and alloying in Au, but it increased by cold work in Cu. Cold work enhanced the recovery above 150°K in Cu and above 50°K in Au. In Au, the stage-III recovery shifted by about 30°K toward lower temperature for cold-worked specimens. (auth)

32562 OPTICAL MEASUREMENTS OF LATTICE DEFECTS IN X-IRRADIATED KCl. Behr, A. (Technische Hochscule, Darmstadt, Ger.). Z. Angew. Phys., 26: 254-61(1969). (In German).

Some investigations were performed to obtain more information about the production of defects in alkali metal halides during x irradiation. All absorption bands caused by lattice defects in KCl were measured. The production of vacancies, i.e., α plus F centers, by x-rays in KCl of different origins, dislocation densities, and divalent impurities was studied at 4.2°K. It is concluded that the generation of vacancies at 4.2°K is an intrinsic process. The annealing behavior of α, F and H centers and an absorption band at 195 nm (I band) show that vacancies and interstitials are formed in KCl during x irradiation at 4.2°K that recombine in distinct annealing stages. An analysis of the annealing curves gives the activation energy and the order of reaction. The colorability of KCl at 77°K depends slightly on dislocation densities, but more on impurities. It is concluded from combined irradiation and annealing experiments at 4.2°K, 77°K and 300°K that the same primary process should be valid for defect formation at these temperatures. (auth)

32563 ANISOTROPIC EFFECTS IN RADIATION DAMAGE OF CRYSTALS. Kumakhov, M. A. (Moscow State Univ.). Phys. Lett., 29A: 243-4(May 19, 1969).

A model of radiation cascade in crystals including ionization loss, atomic scattering anisotropy, and anisotropy effects (channeling and focusing) is proposed. (auth)

32564 ELECTRON RADIATION DAMAGE IN CRYSTALS. Brown, L. M. (Cambridge Univ., Eng.). Phil. Mag., 19: 869-72(Apr. 1969).

The theory of Brown, Kelly and Mayer (1969), intended to explain the effect of boron on the neutron irradiation of graphite, should also be relevant to the case of electron damage in metals. When the theory is applied to the recent data of Shimomura (1969) and Makin (1968), it is found to work well in the former case, but to need modification to allow for the foil surfaces in the latter case. These experiments provide a more direct way of determining the behavior of interstitial atoms in crystals than older methods based on low-temperature annealing studies. (auth) (UK)

32565 ION IMPLANTATION IN SEMICONDUCTORS. Dearnaley, G.; Kandiah, K.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Bull. (London), 20: 165-8 (May 1969).

Semiconductor devices may, with advantage, be produced by the implantation of doping ions into the semiconductor material. A summary is given of the physical principles of the ion implantation process, together with some of the associated problems, under the following headings: Distribution of implanted ions; physical state of ion-implanted solids (radiation damage, fate of implanted atoms); electrical properties of implanted layers and some device considerations. (UK)

32566 POLYGONIZATION OF NaCl SINGLE CRYSTAL SURFACES BY ELECTRON BOMBARDMENT. Agarbiceanu, I.; Teodorescu, I. (Polytechnic Inst., Bucharest, Inst. for Atomic Physics, Bucharest). Phil. Mag., 19: 821-30(Apr. 1969).

The bombardment of NaCl crystals with electrons revealed a surface polygonization. This polygonization was observed on the irradiated zones, as well as outside them. The polygonization was revealed only if the crystal was illuminated during or after the bombardment. Under the action of light the nature of defects (especially the F centers) is changed and affects the mechanical relaxation. (auth) (UK)

32567 HARDENING OF MgO SINGLE CRYSTALS BY ELECTRON AND NEUTRON IRRADIATION. McGowan, W. C.; Sibley, W. A. (Oak Ridge National Lab., Tenn.). Phil. Mag., 19: 967-76(May 1969).

Measurements of the flow stress and optical coloration were made at room temperature on a number of MgO single crystals as a function of neutron and electron irradiation. The flow stress increase due to electron irradiation was found to be proportional to the square root of the concentration of negative-ion vacancies produced by the irradiation. In the case of neutron irradiation the incremental increase in flow stress was proportional to the square root of the neutron dose. A comparison of the data with hardening due to impurity-vacancy pairs in Fe- and Cr-doped MgO indicates that the radiation hardening is due to interstitial type defects. (auth) (UK)

32568 THE NATURE AND PROPERTIES OF COLOR CENTERS FORMED DURING THE PLASTIC DEFORMATION OF IRRADIATED KCl CRYSTALS. El-Shanshoury, I. A. (Atomic Energy Inst., Cairo). Sov. Phys.-Cryst. (Engl. Transl.), 13: 728-33(Mar.-Apr. 1969).

Translated from Kristallografiya, 13: 842-9(Sept.-Oct. 1968).

The nature and properties of color centers formed by mechanical stress were studied. A connection was established between M centers formed as a result of plastic deformation and other centers formed under stress and giving rise to a new thermoluminescence peak at 250°C. The bleaching rate constants were found to be 1.063×10^{-3} sec^{-1} and 3.715×10^{-3} sec^{-1} from M-light bleaching experiments at 17 and 27°C, respectively. The thermal activation energy was also determined from bleaching experiments and found to be 0.94 eV at a frequency of 1.4×10^{-3} sec^{-1}. The value of the thermal activation energy indicates that the stress formed centers are very stable. The value of 0.94 eV is larger than the 0.76 eV obtained by isochronal annealing of second coloration stage F centers and is close to that derived from F-center thermoluminescence measurements. The stability of such centers was demonstrated by their regeneration after complete bleaching with M

light. The experiments detected dichroism between the centers, giving rise to the luminescence caused by plastic deformation and those destructible by M light. It may therefore be concluded that the centers giving rise to the 250°C peak observed during thermoluminescence experiments on plastically deformed crystals are M-type centers with an absorption spectrum corresponding to that of the F centers. (auth)

32569 DETERMINING THE ACTIVATION ENERGY OF FORMATION OF SMOKY CENTERS IN SYNTHETIC QUARTZ CONTAINING ALUMINUM. Samoilovich, M. I.; Tsinober, L. I.; Khadzhi, V. E.; Lelekova, M. V. Sov. Phys.-Cryst. (Engl. Transl.), 13: 734-6(Mar.-Apr. 1969).

Translated from Kristallografiya, 13: 850-3(Sept.-Oct. 1968).

Annealing of crystals of synthetic quartz containing a nonstructural impurity at above 450°C leads to an increase in the smoky coloration revealed by irradiation, owing to transition of nonstructural aluminum to structural positions. On the basis of EPR data, the number of Al centers of smoky coloration is plotted versus time and temperature of annealing, and the activation energy of the process (0.3–0.7 eV) is determined. (auth)

32570 USE OF CHARACTERISTIC X RAYS TO MONITOR ANNEALING OF ION-IMPLANTED DIAMOND. Davidson, L. A. (Stanford Univ., Calif.); Gibbons, James F.; Der, R. C.; Kavanagh, T. M.; Khan, J. M. Appl. Phys. Lett., 14: 295-7(May 1, 1969).

Bombardment of aligned type-IIa diamond substrates with 80-keV protons and simultaneous detection of the resulting characteristic carbon K x rays has revealed excellent channeling structure. This technique has been used to monitor the crystallinity of a surface implanted with $^{31}P^{+}$ ions. Crystallinity was destroyed by $^{31}P^{+}$ doses of the order of $10^{14}/cm^2$. Vacuum annealing at 950°C restored the diamond cubic crystal structure. (auth)

32571 SOME OBSERVATIONS ON CHARGE BUILDUP AND RELEASE IN SILICON DIOXIDE IRRADIATED WITH LOW-ENERGY ELECTRONS. Simons, Mayrant Jr. (Research Triangle Inst., Research Triangle Park, N. C.); Monteith, L. K.; Hauser, J. R. IEEE (Inst. Elec. Electron. Eng.) Trans. Electron Devices, ED-15: 966-73(Dec. 1968).

The positive charge buildup produced in silicone dioxide by low-energy electrons (0 to 30 keV) was investigated as a function of beam energy and oxide thickness. Experiments with higher energy electrons are also reported. The induced charge, from displacement of capacitance vs voltage plots, was found to be a function of the beam energy dissipated within the oxide in the vicinity of the oxide–silicon interface. The charge induced at a particular fluence level in an oxide of given thickness increases with energy up to some level E_{max} beyond which the charge buildup rate falls off as the energy is increased further. Continued falloff in the buildup rate was observed in several samples irradiated at energies of 200 keV and 1 MeV. E_{max} was found to correspond to the beam energy which, according to predicted range–energy data, produces maximum energy dissipation per unit length in the oxide near the silicon interface. The charge induced in samples irradiated at these higher energies was considerably more difficult to remove. From 30 to 60 min at 300°C was required to completely anneal these units. The introduction of deeper trapping levels associated with localized defects produced in the oxide by the high energy electrons may explain this increased difficulty in annealing. Isochronal annealing of samples irradiated at both high and low energies was performed to obtain an activation energy for the trapped charge. Constant-temperature annealing indicated that the annealed charge is linearly dependent on the logarithm of elapsed time over a finite time interval. Such a time dependence of released charge can result either from thermal activation of trapped carriers from a uniform trap distribution or from thermal emission of recombination electrons over a Schottky barrier from the silicon into the oxide. (BBB)

32572 $R \rightarrow F_3^+$ CENTER CONVERSION IN NaF. von der Osten, W.; Roeder, U.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys., 26: 377-80 (1969).

In γ-irradiated NaF, a temporary bleaching of the R_2 zero-phonon absorption line 4480 Å under R_2 light irradiation at 16°K is observed. It is correlated with a simultaneous increase in the optical density of the 5456 Å zero-phonon line. Although the mechanism of the process is unknown, the bleaching effect can be consistently explained by assuming a conversion of R into F_3^+ centers. The changes in optical densities, which prove to be temperature-independent, are reversible after removal of the R_2 light. The results of the experiments support the suggestion that the 5456 Å zero-phonon line is due to a F_3^+ color center transition. (auth)

32573 TEMPERATURE EFFECTS ON CHANNELING OF PROTONS IN SILICON CRYSTAL. Fujimoto, F. (Tokyo Univ.); Komaki, K.; Ozawa, K.; Mannami, M.; Sakurai, T. Phys. Lett., 29A: 332-3(June 2, 1969).

The temperature effects of the {111} and {110} planar channeling of 1.5-MeV protons for silicon thin crystal are investigated. The results show that the low loss component (channeling peak) in energy spectrum of transmitted protons decreases with increasing temperature and its energy value does not change. The half width of the channeling angle is almost independent of temperature. (auth)

32574 X-RAY INVESTIGATION OF LATTICE DEFORMATIONS IN SILICON INDUCED THROUGH HIGH-ENERGY ION IMPLANTATION. Bonse, U. (Univ., Muenster, Ger.); Hart, M.; Schwuttke, G. H. Phys. Status Solidi, 33: 361-74(May 1, 1969).

X-ray interference fringes observed in x-ray topographs of silicon crystals bombarded with high-energy ions (dose > 10^{15} ions/cm^2) are described. The x-ray fringes are used to analyze the deformation state of the crystal. It is shown that the bombarded crystal is a special kind of bicrystal composed of a thick perfect bulk crystal topped by a thin practically perfect layer crystal. Both crystals have the same crystallographic orientation and the same lattice constant but are separated by a small rigid body displacement. Contrast and geometry of the observed x-ray patterns agree with the theoretical patterns calculated by Bonse and Hart (Phys. Status Solidi, 33: 351(1969)) on the basis of a layer/bulk bicrystal model, and are also supported through transmission electron microscopy results. The ion range calculated from the interference fringes is in good agreement with the experimentally determined range. (auth)

32575 THE INFLUENCE OF SUB-THRESHOLD EVENTS ON THE DEFECT PRODUCTION AT LOW-TEMPERATURE ELECTRON IRRADIATION. Dettmann, K. (Univ. of Sussex, Brighton, Eng.). Phys. Status Solidi, 33: 411-16(May 1, 1969).

The general equations for the spontaneous recombination of Frenkel pairs are solved in a perturbation expansion for small defect densities. The damage rate for above- and sub-threshold low-temperature electron irradiation is calculated in linear order of the defect density. (auth)

32576 PRODUCTION OF VACANCIES AND OTHER DEFECTS IN KBr AT LOW TEMPERATURES. Comins, J. D. (Univ. of the Witwatersrand, Johannesburg). Phys. Status Solidi, 33: 445-52(May 1, 1969).

The production rate of vacancies and interstitial defects formed by ionizing radiation in KBr was studied at low temperatures. It was found that the large difference between the production rate of vacancies at liquid helium temperature (LHeT) and liquid nitrogen temperature (LNT) may be accounted for by a combination of thermal annealing processes, interstitial stabilizing processes, and certain additional processes requiring the action of the radiation at LNT. The increase in the production efficiency of vacancies between LHeT and LNT, as predicted by the excitonic mechanism of defect production, is not observed. Studies of the bands produced on warming a crystal irradiated at LHeT to LNT indicate that the V_4 band is the major band produced and that it is produced from the H band. The V_4 envelope formed during irradiations at LTN is shown to consist of the V_4 band produced as above, with the addition of bands at 266 and 306 nm. (auth)

Physical Properties

Refer also to abstract 32286.

32577 (CEA-Bib-142) PHONONS AND THE THERMODYNAMIC PROPERTIES OF SURFACES. Levenson, Leonard L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1969. 22p. (In French). Dep.

The various treatments of the problem are reviewed first. The analysis is then focused on the general theories which yield an evaluation of the surface vibration contribution to the thermodynamic properties of matter. The calculated values of free energy, energy, entropy and heat capacity of the surface are compared with the available experimental values. The orders of magnitude are satisfactory. However, major improvements of the theories must be achieved in order to reach quantitative agreement. (auth)

32578 (COO-1149-149) THERMAL AND ELECTRONIC BEHAVIOR OF THE RARE EARTH HEXABORIDES FROM CRYOGENIC CALORIMETRY. Westrum, Edgar F. Jr. (Michigan Univ., Ann Arbor. Dept. of Chemistry). Apr. 1969. Contract AT(11-1)-1149. 15p. (CONF-690517-1). Dep. CFSTI.

From International Symposium on Rare Earths, Paris and Grenoble, France.

The fundamental problems associated with the interpretation of the electronic and physical properties of these isostructural CsCl-type structures have not advanced greatly in recent years.

This no doubt is partly occasioned by the technical problems encountered in obtaining highly purified, well-characterized samples. Precise, cryogenic thermal measurements have now been completed on LaB_6, CeB_6, PrB_6, NdB_6, and GdB_6. The heat capacity of LaB_6 is of normal sigmate behavior without thermal anomalies (without evidence for superconductivity in accord with resistivity measurements but contrary to other claims). The other hexaborides studied all showed cooperative, anti- to paramagnetic λ-type transitions near 10°K followed by complex Schottky transitions with maxima between 20 and 80 K. The resolution of the magnetic and electronic contributions for the LnB_6's was achieved by means of the heat capacity of diamagnetic LaB_6 as an estimate of the lattice vibrational heat capacity. The corresponding studies on lanthanide sesquioxides from this laboratory provided a basis for extrapolation of this lattice constant to higher hexaborides. For NdB_6, the Schottky anomalies were resolved in terms of energy levels (2,4,4 at 230 and 640 cal gfm^{-1} K^{-1}) generated by the crystal field splitting of the 10-fold degenerate ground state of the assumed Nd^{3+} ion. The data on PrB_6 and CeB_6 (λ at 7°K, Schottky at 35°K) appear to be interpretable on a basis similar to that for NdB_6. However, the results for GdB_6 (λ anomaly at 16°K Schottky maximum 30°K corresponding to a splitting of 61.3 cm^{-1}) are inconsistent with the much smaller expected crystal-field splitting of an $^8S_{\frac{7}{2}}$ ground state. No cogent explanation of the anomaly has yet been postulated. The total transitional entropy in GdB_6 and other properties (lattice parameters, Mössbauer and absorption spectra, magnetic susceptibility, etc.) cast considerable doubt that lanthanide metals are in fact in 3+ oxidation states in some of the hexaborides. Since EuB_6, YB_6, SmB_6, and the alkaline earth hexaborides all contain divalent metal ions, this state may obtain at low temperatures in other lanthanide hexaborides. (auth)

32579 (KR-132) MAGNETISM IN METALS AND ALLOYS. ADVANCED COURSE ORGANIZED BY THE NETHERLANDS', NORWEGIAN REACTOR SCHOOL, SEPTEMBER 16-20, 1968. (Institutt for Atomenergi, Kjeller (Norway)). Sept. 1968. 277p. Dep.

Fifteen lectures by different authors are included on the following topics: electron theory of magnetic metals, positron annihilation, neutron diffraction studies of 3d metals and alloys, polarized neutron scattering and analysis, magnetic susceptibility measurements and their interpretation, structure of rare earth metals and alloys, hyperfine interactions and magnetization from nuclear specific heats and Moessbauer effect, NMR in transition metals, and spin density and magnetic scattering in 3d metals. (D.L.C.)

32580 (ORNL-RMIC-7(Rev.)) BIBLIOGRAPHY OF MAGNETIC MATERIALS AND TABULATION OF MAGNETIC TRANSITION TEMPERATURES. Connolly, T. F.; Copenhaver, Emily D. (comps.) (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 78p. Dep. CFSTI.

This revision includes about 1,000 additional measurements of Curie and Néel points of magnetic materials. A total of 1,224 references is presented. An alphabetical list of the materials by chemical formula is presented in two parts: ferromagnetic (or ferrimagnetic) and antiferromagnetic (or metamagnetic). (D.L.C.)

32581 SPIN-POLARIZED SPLITTINGS IN THE TEMPERATURE-DEPENDENT REFLECTANCE OF EuO. Feinleib, J. (Massachusetts Inst. of Tech, Lexington); Scouler, W. J.; Dimmock, J. O.; Hanus, J.; Reed, T. B.; Pidgeon, C. R. Phys. Rev. Lett., 22: 1385-8(June 23, 1969).

The reflectance of EuO from above the Curie point at 69°K down to 1.5°K shows splittings in the two main peaks near 1.5 and 4.7 eV The first peak is a polarization-dependent triplet at 1.5°K and a doublet at 70°K. The data suggest that the 1.5-eV peak is associated with the absorption edge and arises from the transition $4f^7(^8S_{\frac{7}{2}}) \rightarrow 4f^6(^7F_J)5d\text{-}(t_{2g})$. The narrow t_{2g} sub-band is exchange split by 0.25 eV at low temperatures. (auth)

32582 MAGNETIC SUSCEPTIBILITY OF CUBIC URANIUM TUNGSTEN BRONZES BETWEEN 4.2 AND 560°K. Ostertag, Werner (Corning Glass Works, Corning, N. Y.). Inorg. Chem., 8: 1373-4(June 1969).

The magnetic susceptibility of three uranium tungsten bronzes U_xWO_3 (x = 0.08, 0.10, 0.12) and of a mixed uranium-thorium bronzes $U_{0.033}Th_{0.067}WO_3$ was measured between 4.2 and 560°K. Magnetic susceptibility measurements were made by the Gouy method. The 1/x vs T diagram of the four cubic uranium tungsten bronzes showed that all the curves are linear above roughly 60°K and their linear portions extrapolate to a common value of −170 ± 5°K. At lower temperatures, susceptibilities pass through a maximum at 30°K and then drop rapidly toward zero. Data suggest that antiferromagnetic exchange interactions are the cause of the x-T behavior of U_xWO_3. (D.H.M.)

32583 MAGNETIC PROPERTIES OF σ PHASE OF SOME 3d-TRANSITION ALLOYS. Mori, Nobuo; Mitsui, Tadayasu (Hokkoido Univ., Sapporo). J. Phys. Soc. Jap., 26: 1087-93(May 1969).

Magnetic susceptibility measurement was made on the σ phase of Fe-V, Co-V, Ni-V and Co-Cr binary alloys. The Fe-V system only is ferromagnetic. The temperature-dependent parts of the susceptibility of Fe-V alloys obey the Curie-Weiss law. The paramagnetic moment μ per iron atom in Fe-V varies with vanadium concentration C_v following an empirical relationship, $\mu/\mu B = 2.62 + 173/C_v$, where C_v is atomic % of vanadium. The Curie temperature is sensitive to heat treatments of the specimens, but the magnetic moment is not affected. The susceptibility of the other alloys is found to be nearly temperature-independent. The magnitude of the magnetic moment localized on magnetic atoms at different kinds of sites in these σ phase is suggested. (auth)

32584 ELECTRONS IN METALS AND SEMICONDUCTORS. Greig, D. London, McGraw-Hill, 1969. 167p. 32s.

The following topics are discussed: electrical conduction in solids; electrons in atoms; kinetic theory of gases; energy distributions in classical and quantum gases; atomic bonding; electrons in solids—band structure; electrons in solids—kinetics and the scattering problem; metals (importance of Fermi energy, residual resistance, ideal resistance, Matthiessen's rule and alloys, thermal conductivity, superconductors, superconductors and magnetic fields, the intermediate state, and applications of superconductivity); and semiconductors. (UK)

32585 EFFECT OF THE LOW-TEMPERATURE PHASE TRANSFORMATIONS ON THE ELASTIC BEHAVIOR OF CERIUM. Rosen, M. (Nuclear Research Center, Beer Sheva, Israel). Phys. Rev., 181: 932-5(May 10, 1969).

The temperature dependence of the elastic moduli, adiabatic compressibility, and Debye temperatures of high-purity polycrystalline cerium metal during cooling and warming has been determined in the range between liquid-helium and room temperature. The variation of these properties in the vicinity of the low-temperature phase transformations of cerium is discussed. A sharp minimum in the elastic properties, which is generally indicative of a magnetic ordering transition, was observed at 31°K, and not at about 13°K as was reported from measurements of other physical properties. (auth)

32586 RARE GAS DIFFUSION IN ALKALINE-EARTH FLUORIDES (Kr, Xe IN SrF_2, BaF_2). Felix, F. W. (Hahn-Meitner-Inst., Berlin); Lagerwall, S. Y. T. Phys. Status Solidi, 33: 85-9(May 1, 1969).

The diffusion of Kr and Xe in SrF_2 and BaF_2 has been studied after reactor neutron irradiation using both pure single crystals and single crystals doped with uranium. The activation energies for migration of Kr and Xe in SrF_2 are 1.2 and 3.7 eV, in BaF_2 1.5 and 3.5 eV, respectively. The results are discussed and compared with results on CaF_2. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 31544, 32267, and 32275.

32587 AN IMPROVED SOURCE FOR ^{161}Dy MOESSBAUER EXPERIMENTS. Cohen, R. L.; Guggenheim, H. J. (Bell Telephone Labs. Inc., Murray Hill, N. J.). Nucl. Instrum. Methods, 71: 27-8(1969).

A simple and convenient source, $Gd_{0.5}Dy_{0.5}F_3$, for ^{161}Dy Mössbauer effect measurement, is described. Experimental linewidths of 0.4 cm/sec (fwhm) have been obtained, far better than those previously reported. (auth)

32588 MICROWAVE MAGNETIC RESONANCE TRANSMISSION IN GADOLINIUM. Alexandrakis, George C. Princeton, N. J., Princeton Univ., 1968. 128p.

Thesis.

Reported are the discovery and analysis of a new transmission resonance effect observed in 99.9% pure gadolinium metal. The temperature region studied experimentally, $285 \leq T \leq 327.5$°K, contains the Gd Curie point $T_c \cong 289$°K. The Gd samples were foils about 60×10^{-4} cm thick and were made to form the common wall of two identical microwave cavities, one of which was used for exciting the absorption resonance in the usual sense. A strong resonance signal about 120 db below the microwave source power and several hundred gauss wide was observed in the second cavity. Its origin is the modulation of the microwave penetration depth under resonance conditions. The structure, position, and strength of resonance profiles as functions of temperature are different, depending on the static magnetic field being parallel or perpendicular to the sample surface. The microwave frequency used was $\nu \approx 9.2$ kMHz. A magnon theory of the effect based on the Kubo-Tomita general resonance theory, the Herring-Kittel

magnon theory, and the Bogolyubov–Tyablikov ferromagnetic resonance theory was constructed. Then the classical limit of this theory for the magnon wave number $k \to 0$ was taken as describing the experimental results in the $285°K \leq T \leq 327.5°K$ temperature region. The results of the theory for the paramagnetic temperature region were compared with the corresponding experimental data. The agreement appears to be good and so the resistivity ρ, the susceptibility χ, and the magnetic relaxation time τ of the 4f electrons of Gd were found as functions of temperature in the paramagnetic temperature region. The resistivity values are about 50% lower than the ones obtained by other techniques. The susceptibility results agree with the ones obtained differently. The relaxation time results are the only ones known for Gd. τ was found to be of the order of 10^{-10} sec. (Disser. Abstr.)

32589 DIPOLAR BROADENING OF THE NMR SPECTRUM OF ^{19}F IN UF_4. Gabuda, S. P.; Falaleeva, L. G.; Gagarinskii, Yu. V. (Inst. of Physics, Krasnoyarsk, USSR). Phys. Status Solidi, 33: 435-8(May 1, 1969).

The influence of internuclear dipole-dipole and electron-nuclear dipolar interactions on the NMR spectrum shape was examined for UF_4. It is shown that only the dipolar interaction of the ^{19}F nuclei with the magnetic moments of the U^{4+} ions leads to such a broad NMR spectrum in polycrystalline UF_4 that there is no ground for separating it into several components corresponding to the seven nonequivalent fluorine nuclei in the UF_4 structure. A certain additional broadening of the experimental spectrum may be accounted for by anisotropic hyperfine interaction, due to the transfer of the spin density from U^{4+} to fluorine. (auth)

32590 ELECTRON PARAMAGNETIC RESONANCE OF Fe^{3+} IN MONOCLINIC ZrO_2 AND HfO_2. Gervais, F.; Cabannes, F. (Faculte des Sciences, Orleans, France). Phys. Status Solidi, 33: 453-61(May 1, 1969). (In French).

In the case of monoclinic ZrO_2 and HfO_2, the crystalline field of lower symmetry strongly affects the EPR spectrum of an ion in an S state, here Fe^{3+}; this involves especially the so-called $g \approx 4$ signal. To explain the spectrum, the usual approximations are wrong and leave the necessity to carry out a formal calculation from the second-order Hamiltonian. (auth)

Theory

32591 PARAMETERS OF THE LOCAL PSEUDOPOTENTIAL OF CADMIUM. Maryakhin, A. A.; Svechkarev, I. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi, 33: K37-9(May 1, 1969).

The Cd lattice spectrum was parameterized by a local pseudopotential. Spin–orbit interactions were considered. The Fourier components of the pseudopotential, the spin–orbit coupling coefficient, and the Fermi energy were chosen for the Fermi surface and corrected. The calculations satisfy the data on the radiofrequency size effect. It is shown that the effective masses of Cd measured in cyclotron resonance are influenced by electron–phonon interactions. (D.L.C.)

Theoretical Physics

Refer also to abstract 32276.

32592 (ITF-68-76) ROTATIONAL ENERGY OF THE SYSTEM OF INTERACTING PARTICLES. Davydov, A. S.; Filippov, G. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 19p. Dep.

The problem of separation of rotational motion in a system of interacting particles is considered. The conditions making it feasible are discussed. The congruence between moments of inertia determining the energy of the system rotational states and the spatial distribution of the particles for the case of four particles is ascertained. (auth)

32593 (ITF-69-12) ON SOME QUESTIONS CONCERNING THE KINETICS OF A MODEL SYSTEM ALLOWING THE EXACT SOLUTIONS. Kvasnikov, I. A.; Shelest, A. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 22p. (In Russian). Dep.

A quantum statistical model allowing exact solution is applied to study relaxation processes in systems. Two essentially different types of relaxation are established: a comparatively rapid relaxation connected with the "chaotization" time, after which the system can be described in a "rough" kinetic time scale by Pauli kinetic equations; and relaxation to an equilibrium state described by the above equations. (auth)

32594 SOLUTION OF AN EXACTLY SOLVABLE QUANTUM-MECHANICAL THREE-BODY PROBLEM. Coffou, E. (Inst. Rudjer Boskovic, Zagreb). Nuovo Cim., 61B: 342-54(June 11, 1969).

An exact analytical solution of the quantum-mechanical three-body problem is given in the most general case of isotropic harmonic-oscillator forces acting among particles. (auth)

32595 AN INTEGRAL EQUATION FOR THE SIX-POINT GREEN FUNCTION AND THE MANY-BODY PROBLEM. Ethofer, S.; Schuck, P. (Technische Hochschule, Munich). Phys. Lett., 29A: 223-4(May 19, 1969).

An integral equation for the 6-point Green function is established and a Faddeev-like part extracted. A solution is given of the integral equation in the sense of the RPA. The connection of the mass operator with the 6, 10, 14, ... -point Green function is discussed. (auth)

32596 COVARIANT EQUATIONS OF MOTION FOR A CHARGED PARTICLE WITH A MAGNETIC DIPOLE MOMENT. Suttorp, L. G.; de Groot, S. R. (Univ. of Amsterdam). Phys. Lett., 29A: 249-50(May 19, 1969).

By choosing a covariant position and spin operator equations of motion are derived for a Dirac particle in a nonuniform and time dependent field. (auth)

32597 EXACT SOLUTION OF THE DIRAC EQUATION WITH AN EQUIVALENT OSCILLATOR POTENTIAL. Swamy, N. V. V. J. (Okahoma State Univ., Stillwater). Phys. Rev., 180: 1225-6(Apr. 25, 1969).

It is shown that a Hamiltonian obtained by adding an energy term $\lambda^2\rho_x\sigma \cdot rK|\sigma \cdot L + 1|^{-1}$ to the free particle Dirac Hamiltonian possesses exact solutions and a discrete spectrum of high degeneracy. In the nonrelativistic limit this leads to an isotropic harmonic oscillator with a spin-orbit coupling term of the Thomas–Frenkel form. The symmetry is likely to be at least as high as SU_3. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

32598 (DESY-69/8) ACCURATE CALCULATION OF RADIATION LENGTHS. Knasel, T. M. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb. 1969. 13p. Dep.

Using recent precise calculations of the total cross section for pair production, values for the radiation lengths of elements Z = 2, 6, 13, 29, and 82 are given to an accuracy of 0.1%, and for Z = 1, to an accuracy of 0.5%. In addition, a formula is given which predicts the radiation length for any other element Z ≥ 6 to 1%. The present values represent an improvement over commonly used tables because of the precision of the present prediction, the knowledge of its uncertainty, as well as the extended range of elements included. (auth)

32599 (DESY-69/15) AN UPPER LIMIT FOR THE BRANCHING RATIO $\Gamma(\phi \to \pi^0 + \gamma)/\Gamma(\phi \to \text{all})$. Bemporad, C.; Braccini, P. L.; Castaldi, R.; Foa, L.; Luebelsmeyer, K.; Schmitz, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1969. 11p. Dep.

An experiment was performed at DESY to search for the $\pi^0 + \gamma$ decay mode of the ϕ mesons, photoproduced at 5.5 GeV on a Zn target. From the known production cross section and the calculated detection efficiency, an upper limit for the branching ratio $B = \Gamma(\phi \to \pi^0 + \gamma)/\Gamma(\phi \to \text{all})$ of 0.35% was obtained. (auth)

32600 (LNF-69/6) PROPOSAL FOR A STUDY OF BOSON PRODUCTION AT ADONE USING MAGNETIC ANALYSIS. Note No. 429. Ash, W.; Goggi, G.; Grossman, D.; Murtas, G. P.; Nigro, M.; O'Neill, G. K.; Placidi, M.; Santangelo, R.; Scannicchio, D.; Schiavuta, E. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). June 27, 1969. 25p. Dep.

The decay modes of 1^- vector mesons produced by $e^+ + e^-$ annihilation in the Adone storage ring and the production of meson resonance pairs which give a final state of bosons and photons is proposed. The physics of the program, which yields general information about the dynamics of the $e^+ + e^- \to$ bosons interaction, is described. (J.F.P.)

32601 SECONDARY EMISSION YIELD BY EXTREME RELATIVISTIC PARTICLES. Dell, G. F.; Fotino, M. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 29B: 324-6(May 26, 1969).

Results on the energy dependence of secondary emission from Al and Au are given for electrons and positrons in the energy range 1.5 to 18 GeV. The role of available field-forming distance as analyzed by Aggson is briefly discussed. (auth)

32602 MEASUREMENT OF π^+-He SCATTERING AND ITS RELATION TO THE PION FORM FACTOR. Crowe, Kenneth M.; Fainberg, Anthony; Miller, Jacques; Parsons, Anthony S. L. (Univ. of California, Berkeley). Phys. Rev., 180: 1349-58(Apr. 25, 1969).

A measurement was made of the differential cross section for the elastic scattering of positive and negative pions of energies 51, 60, 68, and 75 MeV scattered from helium. The experiment is discussed and a phase-shift analysis is presented. An optical-model analysis was used to extract the pion electromagnetic radius, yielding 2.96 ± 0.43 F. There remain uncertainties in this application of the model, which are discussed. (auth)

32603 PHOTOPRODUCTION OF NEUTRAL PIONS FROM HYDROGEN IN THE REGION OF THE FIRST PION-NUCLEON RESONANCE. Morand, R.; Erickson, E. F.; Pahin, J. P.; Croissiaux, M. G. (Ecole Normale Superieure, Orsay, France. Institut de Recherches Nucleaires, Strasbourg). Phys. Rev., 180: 1299-1307(Apr. 25, 1969).

The cross section for single π^0 photoproduction from hydrogen was measured at nominal angles of 70°, 90°, 130°, and 180° for photon energies 220 to 400 MeV by detecting the recoil protons. The 180° measurements, taken with a new setup, avoid big corrections present in some of the previously published results. These new data allow a direct comparison with the experiment presented by the Bonn group and with the most recent theoretical predictions. (auth)

32604 EXPERIMENTAL LIMIT ON THE PROTON ELECTRIC DIPOLE MOMENT. Harrison, G. E.; Sandars, P. G. H.; Wright, S. J. (Clarendon Lab., Oxford). Phys. Rev. Lett., 22: 1263-5(June 9, 1969).

A high-precision molecular-beam-resonance experiment has been carried out to look for a violation of P and T invariances in a molecule. The null result can be interpreted in terms of the electric dipole moment of the proton to give $|d_p| = (7 \pm 9) \times 10^{-21}$e cm. (auth)

32605 PHOTOPRODUCTION OF η MESONS ON CARBON NUCLEI. Aleksandrov, Yu. A.; Kutsenko, A. V.; Maikov, V. N.; Pavlovskaya, V. V.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 1009-17(May 1969). (In Russian).

Photoproduction of η mesons on carbon nuclei was investigated at the energies below the production threshold for a single nucleon. The experimental results are qualitatively explicable on basis of the presented model of direct inelastic photoproduction on quasi-free nucleons, yet the results do not agree with the conception of elastic coherent photoproduction on a zero-spin nucleus. (auth)

Weak

32606 (NEVIS-169) CHARGE ASYMMETRY IN K_{e3} DECAY. Saal, Harry J. (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Apr. 1969. Contract AT(30-1)-1932. 87p. (CU-273; R-663). Dep. CFSTI.

Thesis.

The charge asymmetry in K_{e3} decay was measured and found to be $(2.46 \pm 0.59) \times 10^{-3}$ where positron production is favored in the decay. Nonnegligible corrections were applied due to e^+ annihilation and pion interaction phenomena in the ~0.7 gm/cm² of matter in the apparatus. No clear conclusion may be drawn from phenomenological models of CP violation in K-decay because of the unsettled nature of the experimental situation. The μ-e universality appears to be maintained in the CP-violating decay of K_L^0. (auth)

32607 (UCRL-18433) π^0 ENERGY SPECTRUM IN $K^+ \to \pi^0\mu^+\nu$. SEARCH FOR DIRECT RADIATION IN $K^+ \to \pi^+\pi^0\gamma$. Kijewski, Peter Klaus (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 100p. Dep. CFSTI.

Thesis.

An analysis was made of 2041 events of the type $K^+ \to \pi^0 \mu^+ \nu$ to gain some understanding about the matrix element of the strangeness changing hadron current. In this experiment this current describes the transition $K^+ \to \pi^0$. The most general matrix element is written in terms of two Lorentz scalars called form factors. The events for this analysis were obtained from a spark chamber experiment at the Berkeley Bevatron. Both converted γ-rays from the π^0 were observed and the kinematics of each event are completely reconstructed. This allows the π^0 energy distribution to be determined which is used to get information about the form factors f_+ and f_-. The slope of the π^0 energy spectrum is sensitive to the ratio $\xi(0) = f_-(0)/f_+(0)$. Assuming that f_+ and f_- are independent of q^2, the result $\xi(0) = -0.3 \pm 0.3$ is obtained from a measurement of the slope. A q^2 dependence of f is introduced by means of a linear approximation. Taking $\lambda_- = 0$ and fitting the data to $\xi(0)$ and λ_+ it is found that: $\xi(0) = -0.5$ and $\lambda_+ = 0.009$. In a separate experiment a search was made for events of the type $K^+ \to \pi^+ \pi^0 \gamma$. These events are distinguished by the fact that they produce three showers in the spark chambers. The decay $K^+ \to \pi^+ \pi^0 \gamma$ would be of interest in studying time reversal invariance if one could observe decays produced by direct radiation rather than inner bremsstrahlung. The two types of events can be told apart by the fact that for inner bremsstrahlung the γ-ray is mostly emitted in the same direction as the π^+, while for direct radiation the γ-ray is emitted in the opposite direction to the π^+. 27 events which satisfy a two constraint fit to the kinematics of $K^+ \to \pi^+ \pi^0 \gamma$ were analyzed in terms of the decay rate. It is assumed that direct radiation is dominated by dipole radiation. The result shows that the events are distributed in the variable $\vec{p}^+ \cdot \hat{\gamma}$ as would be expected from inner bremsstrahlung without the presence of direct radiation. (auth)

32608 MEASUREMENT OF THE AXIAL-VECTOR TO VECTOR COUPLING CONSTANT, $|g_1/f_1|$, IN $\Sigma^- \to ne^- \bar{\nu}$ DECAY. Eisele, F.; Engelmann, R.; Filthuth, H.; Foehlisch, W.; Hepp, V.; Leitner, E.; Presser, W.; Schneider, H.; Stevenson, M. L.; Zech, G. (Univ., Heidelberg). Z. Phys., 223: 487-99(1969).

The ratio of the axial-vector to vector coupling constant, $|g_1/f_1|$, in the $\Sigma^- \to ne^- \bar{\nu}$ decay was determined from the electron-neutrino

angular distribution. In a sample of 454 $\Sigma^- \to ne^- \bar{\nu}$ decays a search was made for subsequent neutron proton scattering in order to detect the decay neutrons. The Σ hyperons were produced by stopping K^--mesons in the 81 cm Saclay hydrogen bubble chamber. For the kinematical analysis 33 $\Sigma^- \to ne^- \nu$ events with associated $np \to np$ interactions were accepted. The value $|g_1/f_1| = 0.37^{+0.8}_{-0.5}$ was obtained. (auth)

32609 ENERGY SPECTRUM OF THE π^+ IN $K^+ \to \pi^+\pi^0\pi^0$. Davison, D. (Univ. of California, Riverside); Barkas, W. H.; Evans, D. A.; Fung, S.-Y.; Porter, L. E.; Poe, R. T.; Greiner, D. Phys. Rev., 180: 1333-8(Apr. 25, 1969).

Measurements were made of the low-energy portion of the τ' spectrum in emulsion and the high-energy portion in a heavy-liquid bubble chamber. The final data consist of 642 events in emulsion and 3406 events in the bubble chamber. Fits were made to several models, including the linear spectrum and the Brown–Singer σ resonance. The data somewhat favor the σ-resonance model. (auth)

32610 LIFETIMES OF LIGHT HYPERFRAGMENTS. II. Phillips, R. E.; Schneps, J. (Tufts Univ., Medford, Mass.). Phys. Rev., 180: 1307-18(Apr. 25, 1969).

Studies of the lifetimes of light hyperfragments are continued. The analysis is based on a total sample of 1476 mesonic decays of hyperfragments, of which 77 decayed in flight. The values found for the mean lives are the following: $\tau({}_\Lambda H^3) = (2.85^{+1.0}_{-0.6}) \times 10^{-10}$ sec, using both two-body and three-body decays; $\tau({}_\Lambda H^4) = (2.68^{+1.0}_{-0.6}) \times 10^{-10}$ sec, using only three-body decays; $\tau({}_\Lambda He^4) = (2.28^{+1.0}_{-0.5}) \times 10^{-10}$ sec; $\tau({}_\Lambda He^5) = (2.51^{+1.0}_{-0.6}) \times 10^{-10}$ sec; and $\tau({}_\Lambda He^{4,5}) = (2.43^{+0.6}_{-0.4}) \times 10^{-10}$ sec for the combined mean life of all the ${}_\Lambda He^4$ and ${}_\Lambda He^5$ events. The last lifetime quoted contains only a statistical error. The others, in addition, contain in their errors the effects due to uncertainties in our knowledge of the bias for two-body events and of the separation of ambiguous three-body events. All the results are in good agreement with theoretical calculations of hyperfragment lifetimes. (auth)

32611 STUDY OF K_{e4} DECAYS. Ely, Robert P. Jr. (Univ. of California, Berkeley); Gidal, George; Hagopian, Vasken; (and others). Phys. Rev., 180: 1319-30(Apr. 25, 1969).

A study of 13.3×10^6 stopped K^+ in a heavy-liquid bubble chamber yielded 269 K_{e4} decays of the type $e^+\pi^+\pi^-\nu$, a total greater by a factor of 4 than the number found in a previous experiment. No examples of $e^-\pi^+\pi^+\bar{\nu}$ were found. With 95% confidence, the upper limit for the decay rate of $K_{e4}(e^-)$ was found to be 56 sec^{-1}. The rate for $K_{e4}(e^+)$ was found to be $(2.60 \pm 0.30) \times 10^3$ sec^{-1}. The angular distributions and the dipion invariant-mass plot were fitted by varying the form factors f_s, f_p, g, and h, and the difference between s- and p-wave π-π phase shift. Two acceptable solutions were found. Both agree that the vector form factor h is significantly nonzero and that its sign is negative with respect to that of f_s. Also, it was found necessary to include f_p in order to obtain a good fit. Although both solutions give the magnitude of the phase difference to be 25 ± 9 deg, the two estimates have opposite signs. No evidence of a σ resonance is seen. The angular distributions are found to be consistent with time-reversal invariance, and with the locality of lepton production. (auth)

Strong (Baryon-Induced)

32612 (BNL–13671) DESCRIPTION OF FINAL STATES WITH THREE, FOUR, AND FIVE PARTICLES IN pp INTERACTIONS AT 28.5 GeV/c. Ellis, W. E.; Morris, T. W.; Panvini, R. S.; Thorndike, A. M. (Brookhaven National Lab., Upton, N. Y.). [1969]. 33p. (CONF-690608–2). Dep. CFSTI.

From International Conference on Elementary Particles, Lund, Sweden.

Additional experimental findings concerning the final states $pn\pi^+$, $pp\pi^+\pi^-$, and $pn\pi^+\pi^+\pi^-$ from a continuing study of pp interactions at 28.5 GeV/c are presented. The diffraction-dissociation process appeared to account for most of the cross section in the $pn\pi^+$ and $pp\pi^+\pi^-$ final states; for the five-body final state no strong clustering of particles at low mass was seen. It is found that the five-particle final state $pn\pi^+\pi^+\pi^-$ has the characteristic shape of a diffraction-dissociation process in the $n\pi^+\pi^+\pi^-$ mass spectrum if it is recognized that this mass distribution is sufficiently broad so that it occupies a large part of the allowed mass region. The $n\pi^+$ and $p\pi^+\pi^-$ systems in the three- and four-body final states show a marked resonant-like structure near 1.4 GeV. A detailed survey of the mass and t distributions are emphasized, particularly for the $pn\pi^+$ and $pp\pi^+\pi^-$ final states. A Monte Carlo calculation, which uses an empirical formula based on the assumption of a diffraction-dissociation mechanism, gives a good gross description of distributions in the data. In particular, the center-of-mass longitudinal momenta of all particles in the final state $pn\pi^+\pi^+\pi^-$ are explained in terms of the latter technique. (L.B.S.)

32613 NEUTRON–PROTON ELASTIC SCATTERING IN THE FORWARD DIRECTION BETWEEN 4 AND 16 GeV. Engler, J. (Institut fuer Experimentelle Kernsphysik, Karlsruhe, Ger.); Horn, K.; Koenig, J.; Moennig, F.; Schludecker, P.; Schopper, H.; Sievers, P.; Ullrich, H.; Runge, K. Phys. Lett., 29B: 321-3(May 26, 1969).

The differential cross section for the elastic neutron-proton-scattering was measured for neutron energies between 4 and 16 GeV and $|t|$ from 0.3 to 1.3 $(GeV/c)^2$. The results can be fitted by $\exp(A + Bt)$, where B increases slightly with energy indicating shrinkage. The values of B for n-p scattering are in good agreement with the corresponding data for p-p scattering. (auth)

32614 EFFECTIVE TARGET MASS IN PROTON–NUCLEON AND PION–NUCLEON INELASTIC INTERACTIONS AT 16 AND 28 GeV/c. Wang, P. Y.; Jain, P. L. (State Univ. of New York, Buffalo). Nuovo Cim., 61A: 567-81(June 1, 1969).

Samples of 62 proton-nucleon and 121 pion-nucleon interactions in 28 and 16 GeV/c pion beams respectively, were found in nuclear emulsions by following the along-the-track method. The effective-target-mass distribution for these events was obtained from three independent methods. An empirical relation was derived which could be used for finding the effective target mass from nucleon-nucleon and pion-nucleon interactions from the angular distribution of shower particles produced in these interactions. The distribution of γ_c (Lorentz factor in the center-of-mass system) is given with a narrow spread and is shown against an effective target mass of individual events. This distribution further supports the results of the above three methods. The inelasticity of these events is also discussed in the laboratory as well as in the "mirror" system. (auth)

32615 SINGLE PION PRODUCTION IN ANTIPROTON–PROTON INTERACTIONS AT 2.7 GeV/c. Sears, Robert Frederick Jr. Boulder, Colo., Univ. of Colorado, 1968. 118p. Thesis.

Interactions of 2.7-GeV/c antiprotons with protons resulting in the following final states were studied: (1) $\bar{p}p\pi^0$, (2) $\bar{p}n\pi^+$, and (3) $\bar{n}p\pi^-$. This study is based on interactions in 26,000 photographs from the Shutt 20" liquid hydrogen bubble chamber at Brookhaven National Laboratory. Of the 15,452 events measured, 914 were identified uniquely as final state (1), 884 as final state (2), and 882 as final state (3), with an additional 245 events ambiguous between two or more identifications. In this experiment one interaction corresponds to a 2.71 microbarn cross section. The final states (1), (2), and (3) are found to have cross sections in millibarns of 2.64 ± 0.08, 2.61 ± 0.08, and 2.68 ± 0.09, respectively, including the ambiguous fits. These final states demonstrate an invariance under the operation of CR, where C is the charge conjugation operator and R is an operator which causes a rotation of 180° about an axis perpendicular to the direction of the incident antiproton in the overall CM. This invariance is expected since the initial $\bar{p}p$ state, for an unpolarized beam, is an eigenstate of the operator CR. A Deck calculation is performed under the assumption that the one pion exchange is the dominant mechanism for these interactions and that the two OPE diagrams for each final state add incoherently. This calculation reproduces the experimental angular distributions but not the mass distributions, indicating that this model for the interaction is insufficient to describe it. A Regge-pole calculation results in better agreement with the data, but even this is not satisfactory. The conclusion that both of these calculations seem to imply is that something besides one pion exchange is necessary to describe these interactions. (Disser. Abstr.)

32616 PROTON–NUCLEUS INTERACTIONS AT 3 GeV/c IN NUCLEAR EMULSIONS. Bogdanski, M.; Jeannet, E.; Metzger, C. (Univ., Neuchatel, Switzerland). Helv. Phys. Acta, 42: 485-96(May 16, 1969). (In French).

The results of an analysis of about 700 "stars" induced by 3-GeV/c protons in photographic emulsion are presented. A new technique used for measuring the tracks is described. Size distributions of stars in terms of black, grey and shower tracks, angular distributions of emitted particles, energy spectra of protons and alphas, emission ratios of protons and alphas as well as the excitation energy distribution of the residual nuclei after the intranuclear cascade are in good agreement with the cascade-evaporation model of nucleon–nuclei high energy interactions. (auth)

32617 DATA COMPILATION OF BARYON–BARYON INTERACTIONS. III. HYPERON–PROTON COLLISIONS. Alexander, G.; Benary, O.; Karshon, U.; Maor, U. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., B10: 554-62(1969).

A survey of experimental data on proton interactions with the hyperons (Λ), (Σ^+), and (Σ^-) is presented. Restriction is made to basic experimental information. No cut off on the incident hyperon

momentum is imposed. This survey includes data published during the period from January 1, 1954, to December 31, 1968. (J.F.P.)

32618 A STUDY OF SURVIVING ANTIPROTONS AT 5 GeV/c WITH THE EMULSION TECHNIQUE. Raghavan, Indira; Kamal, A. A.; Padmi, S. V.; Santhalaxmi, A. (Osmania Univ., Hyderabad, India). Nucl. Phys., B11: 177-85(1969).

The survival probability of $\bar{p}$ of 5 GeV/c, in their interactions with the nuclei of emulsion, is found to be 0.09 ± 0.01. The non-annihilation cross section per nucleon for interactions in which the $\bar{p}$ re-emerges, is estimated to be 13.7 ± 1.1 mb for r_0 = 1.5 fm. (auth)

32619 REGULARITY OF MULTIPLICITY DISTRIBUTION IN NN AND πN COLLISIONS AND THE STRUCTURE OF THE NUCLEON. Wang, Chia Ping (Case Western Reserve Univ., Cleveland). Phys. Rev., 180: 1463-7(Apr. 25, 1969).

The frequencies for the various numbers of charged secondaries from pp, $\pi^{\pm}$p, pn, $\pi^{\pm}$n, and nn collisions from below production threshold to 27-BeV primary energy were found to define a single set of curves which can be expressed by a universal set of "multiplicity distribution functions" constructed from Poisson terms when conservation laws are suitably incorporated. The distribution functions so obtained contain no adjustable parameter and fit well the NN cosmic-ray jets at 100 to 250 BeV, the highest energy at which NN collision data are available. The ΛK° accompanying the pions produced by π^-p were also found to follow the same distribution. The multiplicity regularity found points immediately to the existence of a number of nearly identical regions or "cells" inside the nucleon and the fireball. (auth)

32620 ANGULAR DISTRIBUTION OF SECONDARY CHARGED PARTICLES IN INELASTIC pN INTERACTIONS AT ENERGY OF 20 GeV. Takibaev, Zh. S.; Pavlova, N. P.; Pervushina, V. L.; Rus'kina, G. Ya. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 9: 1034-9(May 1969). (In Russian).

Asymmetrical showers with $\alpha = \pm 1$ and showers with two maxima in the angular distribution in the coordinates $\lg\operatorname{tg}\theta_l - \langle\lg\operatorname{tg}\theta\rangle$, selected with the parameters $\sigma \geq 0.6$ and $D > 0$, were investigated. It is shown that the asymmetrical ($\alpha = \pm 1$) cases and the "two-bump" cases are apparently results of fluctuations in the angular distributions of secondary particles. (auth)

Strong (Meson-Induced)

Refer also to abstracts 32614 and 32619.

32621 (BNL-13681) FURTHER EVIDENCE FOR $Y_1^*(1616)$ FROM 3.9 GeV/c K^-n INTERACTIONS. Crennell, David J.; Karshon, Uri; Lai, Kwan Wu; O'Neall, John S.; Scarr, J. Michael (Brookhaven National Lab., Upton, N. Y.); Baumel, Philip; Lea, Robert M.; Schumann, Thomas G.; Urvater, Ernest M. (City Coll., New York. Dept. of Physics). May 20, 1969. 19p. (CONF-690608-1). Dep. CFSTI.

From International Conference on Elementary Particles, Lund, Sweden.

The existence of an I = 1 Λπ resonance with mass 1619 ± 8 MeV and width 72(+22,-15) MeV is confirmed in a study of K^-d interactions in the BNL 80" bubble chamber. Events from approximately 200,000 pictures were measured. Evidence for the $Y_1^*(1619)$ occurs principally in events fitting the $K^-n \to \Lambda\pi^+\pi^-\pi^-$ interaction. (L.B.S.)

32622 RESONANCE PRODUCTION IN Yππ FINAL STATES OF K^-p INTERACTIONS AT 1.33 GeV/c. Gordon, H. A. (Univ. of Illinois, Urbana); Ficenec, J. R.; Trower, W. P. Nuovo Cim., 61A: 353-68(June 1, 1969).

A study was made of three final states involving a hyperon and two pions produced by 1.33 GeV/c negative kaons in the Lawrence Radiation Laboratory 72-inch hydrogen bubble chamber. The $Y_1^*(1385)$ dominated the $\Lambda\pi^+\pi^-$ final state while the $Y_0^*(1405)$ and the $Y_0^*(1520)$ were prominent in the $\Sigma^{\pm}\pi^0\pi^{\mp}$ final states. The partial cross sections, masses, widths and production angular distributions of the resonances were obtained. Resonance production was determined to proceed mainly through the s-channel. (auth)

32623 DOUBLE-RESONANCE PRODUCTION BY 5 GeV/c K^+ MESONS ON PROTONS. De Baere, W. (Laboratoire Interuniversitaire Belge des Hautes Energies, Brussels); Debaisieux, J.; Dufour, P.; (and others). Nuovo Cim., 61A: 397-420(June 1, 1969).

Among the interactions of K^+p at 5 GeV/c produced in the CERN 2 m and Saclay 81 cm hydrogen bubble chambers the four-body reactions $K^+p \to KN\pi\pi$ were studied. The cross sections for the various final states contributing to these reactions were determined. A detailed analysis was performed on the double-resonance production $K^+p \to K^*(892)\,N^*(1236)$. Decay angular distributions for both resonances were studied and single and joint spin-density matrix elements were calculated as a function of four-momentum transfer. The results were compared to the absorption-model predictions assuming pion exchange. Various quark-model predictions for the decay angular distributions were tested. The quark-model relations derived on the basis of the additivity assumption only, are experimentally well satisfied. If additional conditions about the quark–quark scattering amplitudes are imposed, only some of the quark-model predictions agree with experiment. (auth)

32624 EXPERIMENTAL INVESTIGATION OF THE MECHANISM OF THE $^{12}C(\pi^-,\pi^-p)^{11}B$ REACTION AT π^- MOMENTUM 1.04 GeV/c. Aganyants, A. O.; Bayukov, Yu. D.; Deza, V. N.; (and others) (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys., B11: 79-92(1969).

The distributions which are necessary for the identification of the mechanism of the $^{12}C(\pi^-,\pi^-p)^{11}B$ reaction were obtained: residual nucleus excitation energy and momenta spectra, angular distribution of the residual nuclei. Treiman–Yang angle distribution, π^- meson momentum distribution at fixed angle, distributions of invariant mass of the π^-p system and of the angle between π-meson and proton. The ^{12}C proton width was determined and compared with the same quantity obtained from other reactions. It was concluded that the pole mechanism dominates only in the region of recoil momenta ≤130 MeV/c. (auth)

32625 THE FORMATION OF $Y_1^*(1665)$ IN THE REACTION $K^-n \to \Sigma^-\pi^0\pi^-$. Armenteros, R. (CERN, Geneva); Baillon, P.; Minten, A.; Khanh, Nguyen H.; Pelosi, V.; Crozon, M.; Louedec, C.; Narjoux, J. L.; Pierre, F. Nucl. Phys., B10: 459-66(1969).

The reactions $K^-d \to p\Sigma^-\pi^0\pi^-$ in the Σπ mass range from 1600 to 1800 MeV were studied. The cross sections and angular distributions obtained are represented in a partial wave parametrization. A resonant amplitude of the D_{13} wave around a mass of 1680 MeV is found. The amplitude is $T_R = \sqrt{\Gamma(\Sigma\pi)\cdot\Gamma(\bar{K}N)} = 0.19$, independent of the behavior of background amplitudes. (auth)

32626 LONGITUDINAL MOMENTUM PLOTS IN THREE-BODY FINAL STATES WITH STRANGENESS MINUS ONE. Ochs, W. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Phys., B10: 453-8(1969).

Various 6-GeV/c K^-p three-body reactions with three strange particles in the final state are discussed using longitudinal momentum plots. (auth)

32627 $\pi^{\pm}$p ELASTIC SCATTERING IN THE 2-GeV REGION. Busza, W. (University Coll., London); Duff, B. G.; Heymann, F. F.; (and others). Phys. Rev., 180: 1339-48(Apr. 25, 1969).

$\pi^{\pm}$p elastic differential cross sections in the momentum range 1.72 to 2.80 GeV/c were measured at the proton synchrotron "NIMROD" of the Rutherford High Energy Laboratory. The results are tabulated, and analyses of the differential cross sections employing optical models and Legendre polynomial expansions are advanced. A critical discussion of a recent interpretation of differential-cross-section structure in terms of interference between resonant and background amplitudes is presented. (auth)

32628 STUDY OF THE PRODUCTION OF LOW-MASS $K^*\pi$ SYSTEMS IN 12.7-GeV/c K^+p COLLISIONS. Farber, M. S.; Ferbel, T.; Slattery, P. F.; Yuta, H. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 22: 1394-7(June 23, 1969).

The production and decay characteristics of low-mass $K^{*0}(890)\pi^+$ systems produced in the reaction $K^+p \to K^+p\pi^+\pi^-$ at 12.7 GeV/c were studied. Comparisons between these data and two diffractive production models are presented. (auth)

32629 IS THERE AN η(550)π RESONANCE AT 980 MeV? Crennell, David J.; Karshon, Uri; Lai, Kwan Wu; O'Neall, John S.; Scarr, J. Michael (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 22: 1398-1401(June 23, 1969).

The 980-MeV enhancement in the effective-mass spectrum of the π^- + neutrals is observed in the reaction $K^-n \to \Lambda\pi^-$ neutrals, when the effective mass of the neutrals lies in the η(550) region. However, no corresponding enhancement is seen when the η decays by the charged modes. An effect found in the $\rho^0\pi^-$ system from the final state $\Lambda\pi^+\pi^-\pi^-$, when extended to $\Lambda\rho^-\pi^0(\to \Lambda\pi^-\pi^0\pi^0)$, predicts the observed enhancement in the $\Lambda\pi^-$ neutrals final state and accounts for its absence when charged η decays are considered. (auth)

32630 A_2 MESON PRODUCTION FROM K^-n INTERACTIONS AT 3.9 GeV/c. Crennell, David J.; Karshon, Uri; Lai, Kwan Wu; O'Neall, John S.; Scarr, J. Michael (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 22: 1327-30(June 16, 1969).

The observation is reported of one narrow $\rho^0\pi^-$ resonance in the $A_2(1300)$ mass region with a width of 40 MeV or less from the reaction $K^-n \to \Lambda\rho^0\pi^-$. A spin-and-parity analysis of this narrow

enhancement favors $J^{PC} = 1^+$. Branching ratios for other decay modes are also given. (auth)

32631 ELASTIC SCATTERING OF NEGATIVE PIONS FROM DEUTERONS AT 2.01, 3.77, AND 5.53 GeV/c. Fellinger, M. (Iowa State Univ., Ames); Gutman, E.; Lamb, R. C.; Peterson, F. C.; Schroeder, L. S.; Chase, R. C.; Coleman, E.; Rhoades, T. G. Phys. Rev. Lett., 22: 1265-9(June 9, 1969).

The differential cross sections for the elastic scattering of negative pions by deuterons were measured for 2.01-, 3.77-, and 5.53-GeV/c incident pion momenta, over an interval of the squared four-momentum transfer from -0.25 (GeV/c)^2 to ~ -1.0 (GeV/c)^2. The results are consistent with calculations based on a Glauber model of the scattering process. (auth)

32632 STUDY OF THE CHARGE EXCHANGE REACTION $\pi^- + p \rightarrow \pi^0 + n$ WITH THE π^0 MESON BACKWARD EMISSION AT 1.55 TO 3.8 GeV/c. Antopol'skii, V. D.; Bayatyan, G. L.; Brakhman, E. V.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1021-4(May 1969). (In Russian).

Charge exchange reaction $\pi^- + p \rightarrow \pi^0 + n$ with the backward π^0 meson emission at 1.5 to 3.8 GeV/c was studied. The γ quanta from the backward π^0 meson were registered in spark chambers surrounding the liquid hydrogen chamber; forward scattered neutron was registered in the spark chamber of a neutron detector. Kinematics of the events and the effective mass of two quanta were determined measuring γ quanta emission angle and the interaction point of the recoil neutron. The data on the dependence of differential cross sections on the energy at 1.5 to 3.8 GeV/c for $\cos\theta^* = -0.99 \pm 0.01$ are presented. (auth)

32633 INTERACTION OF COSMIC PIONS WITH GRAPHITE NUCLEI. Erofeeva, I. N.; Mishchenko, L. G.; Murzin, V. S.; Sarycheva, L. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 9: 232-4(Apr. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 390-4(Apr. 5, 1969).

For the investigation of nuclear-active particles at mountain altitudes an experimental setup is used which makes it possible to measure the energy of the nuclear-active particles interacting in a graphite filter, the energy transferred in this interaction to the electron–photon component, the multiplicity of the secondary and of the newly created particles and their emission angles, and the presence of charge in the produced particle. The method used to separate the pions from the charged primary particles is described, and the main characteristics of 41 interactions are listed. The average energy for these interactions is approximately 200 GeV. From these data it is concluded that the pion interactions differ in character from the showers produced by the nucleons. It is found that the average multiplicity of secondary particles in the pion interactions is smaller than that for nucleon interactions. (J.F.P.)

32634 CORRELATIONS BETWEEN LONGITUDINAL AND TRANSVERSAL MOMENTUM COMPONENTS OF SECONDARY PARTICLES PRODUCED IN π^-p INTERACTIONS AT 4.0 GeV/c. Bannik, B. P.; Kuznetsov, A. A.; Mel'nikova, N. N.; Chadraa, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 1025-33(May 1969). (In Russian).

Distributions of transversal $p_\perp$ and longitudinal $p_\parallel$ momenta of secondary particles produced in π^-p interactions with production of strange particles are studied. A dependence of $\bar{p}_\perp$ on the particle mass has been observed. Dimensions of the interaction region are estimated. An indication is obtained to the conservation of the Lorentz contraction of the interaction region in process of π^--meson collision with proton. A correlation between $p_\perp$ and $p_\parallel$ for π and K^0 mesons is observed. (auth)

32635 IMPROVEMENT OF THE BRANCHING RATIO $(A_2^- \rightarrow \pi\eta)/(A_2^- \rightarrow \pi\rho)$ AT THE INCIDENT π^--MESON MOMENTUM OF 3.25 GeV/c. Vetlitskii, I. A.; Grigor'ev, V. K.; Grishin, A. P.; (and others). (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1018-20(May 1969). (In Russian).

The cross sections of the following reactions at 3.25 GeV/c were determined: $\pi^-p \rightarrow pA_2^- \rightarrow p\pi^+\rho^0$, $\sigma = 170 \pm 35$ mkb; $\pi^-p \rightarrow pA_2^- \rightarrow p\rho^-\pi^0$, $\sigma = 142 \pm 31$ mkb; $\pi^-p \rightarrow pA_2^- \rightarrow p\pi^-\eta^0$, $\eta^0 \rightarrow \pi^+\pi^-\pi^0$, $\sigma = 20 \pm 6$ mkb; $\pi^-p \rightarrow pA_2^- \rightarrow p\pi^-\eta^0$, $\eta^0 \rightarrow$ neutrals, $\sigma = 36 \pm 12$ mkb. With the data the branching ratio was found to be $R = (A_2^- \rightarrow \pi\eta)/(A_2^- \rightarrow \pi\rho) = 0.18 \pm 0.06$. (auth)

32636 DIFFRACTION PRODUCTION OF PIONS BY PIONS WITH MOMENTUM 7.5 GeV/c. Abdullaeva, K. N.; Azimov, S. A.; Azimova, M.; Gulyamov, U. G.; Prozorova, E. I.; Rizaev, Kh. A.; Yuldashev, A. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 75(1969). (In Russian).

Results of the study of diffractive dissociation of pions on the carbon nucleus at a momentum of 7.5 GeV/c with three charged pions are given. The cross section of the studied process was determined on the basis of 350 events in propane bubble chamber photographs. (auth)

32637 LIFETIME OF NEUTRAL PION. Kryshkin, V. I.; Sterligov, A. G.; Usov, Yu. P. (Tomsk Polytechnic Inst., USSR). JETP Lett. (USSR) (Engl. Transl.), 9: 251-3(Apr. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 420-4(Apr. 5, 1969).

Preliminary results are reported from an experiment for the investigation of the photoproduction of mesons (π^0) in the Coulomb field of a nucleus) the Primakoff effect). In this experiment spark chambers and scintillation counters detect the results of a bremsstrahlung beam reaction with a lead target at a maximum energy of 1.1 GeV. A plot is made of the distribution of the mesons (π^0) with an angular resolution $\Delta\theta = 7'$. The peaks of the Coulomb and the coherent production are clearly separated. The lifetime of the neutral pion is determined to be $0.900\ (10)^{-16}$ seconds with an accuracy of ±8%. (J.F.P.)

32638 CERTAIN CHARACTERISTICS OF NUCLEAR INTERACTIONS OF π^- MESONS WITH MOMENTUM 50 GeV/c. Zhdanov, G. B.; Tret'yakova, M. I.; Chernyavskii, M. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 9: 234-8 (Apr. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 394-400(Apr. 5, 1969).

Emulsions of the BR-2 type were irradiated by a meson (π^-) beam having a momentum of 50 GeV/c. In the meson–nucleon cms the angular distribution of the produced charged particles has an appreciable forward asymmetry in approximately 50% of all cases. In a noticeable fraction of all cases the interactions are characterized by a transfer of an appreciable fraction of the energy to the neutral mesons. At a multiplicity $n \leq 5$ one particle with a preferred emission angle appears among the charged secondary particles with a probability of approximately 50% and carries away more than 20% of the initial energy. When the multiplicity increases to 6 and more charged particles all the foregoing singularities of the process are gradually lost. (J.F.P.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 32856 and 32954.

32639 BEHAVIOR OF THE DIFFRACTION PEAK FOR PARTICLES WITH ARBITRARY SPINS. Nguyen Ngoc, Thuan (Joint Inst. of Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 9: 187-9(Mar. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 318-20(Mar. 5, 1969).

It was previously shown, by determining the width of the diffraction peak of processes in which scalar particles take part, namely $a + b \rightarrow a + b$ (I) and $a + b \rightarrow c + d$ (II) $\Delta^{I,II} = \sigma^{I,II}/(d\sigma^{I,II}/dt)$, that $\Delta^{I,II}$ cannot decrease with increasing S (the square of the energy) more rapidly than const/$\ln^2$ S. It is shown that this behavior holds also in the case of particles with spins, and explicit expressions are obtained for the constants preceding the indicated functions of S. (L.B.S.)

32640 HANKEL-TRANSFORMED PERTURBATION-THEORY FUNCTIONS. Andersson, Bo (Univ. of Lund, Sweden). Nucl. Phys., B10: 527-53(1969).

The Hankel transforms with regard to the internal mass parameters of the perturbation-theory functions in momentum space are studied. Suitable representation formulas are derived and compared to similar formulas for related functions. The singularity structure of the functions considered as analytic functions of the external momentum variables is investigated and representation formulas constructed. The end-point singularities of the representation integrals are identified with the main singularities of simpler Hankel-transformed perturbation functions and general rules are given to construct the corresponding functions from graph-theoretical considerations. (auth)

32641 FERMION AVATARS OF THE SUGAWARA MODEL. Coleman, Sidney; Gross, David; Jackiw, Roman (Harvard Univ., Mass.). Phys. Rev., 180: 1359-66(Apr. 25, 1969).

It is argued that the expression for the energy-momentum tensor as a quadratic function of currents given in the Sugawara model

must be reinterpreted as the limit of the corresponding expression, with the currents given a small separation minus its vacuum expectation value as the separation goes to zero, if the expression is to have any chance at all of making sense in a quantum field theory. This limit is calculated for a wide class of free Dirac theories with the usual currents in both two and four dimensions. In many (though not all) cases, it is found that the limit yields the usual energy-momentum tensor. In calculating the limit in four dimensions, multiplication by the square of the separation is performed to ensure that the limit exists; this is a reflection of the divergence of the Schwinger terms in the equal-time commutators of currents. (auth)

32642 ADVANCED EFFECTS IN PARTICLE PHYSICS. I. Csonka, Paul L. (Univ. of Oregon, Eugene). Phys. Rev., 180: 1266-81(Apr. 25, 1969).

The relation between causal sequence and time sequence of events is investigated. A theory is constructed which is able to describe the interaction of particles with arbitrary quantum numbers, and in which the elementary interaction is time-symmetric between effect and cause: The effect may precede as well as follow the cause. It is shown that in a many-particle universe, under certain conditions, effects mostly follow the cause, but that this phenomenon is a function of the coupling constants. The direction of time is correlated with the distribution of particles in four-dimensional space. The "velocity of time" (related to the average change of entropy per collision) is introduced and found to be almost zero for an almost empty universe. It is suggested that the causal chain may be closed in our universe. An experiment is described which may be able to test these ideas. In one of the appendices two generalizations of the optical theorem is given, the first of which is valid even if unitarity is not. (auth)

32643 NONFACTORIZING SATURATION OF CURRENT ALGEBRA. Hamprecht, B. (Univ. of Colorado, Boulder); Kleinert, Hagen. Phys. Rev., 180: 1410-3(Apr. 25, 1969).

A general method is devised by which nonfactorizing solutions (i.e., those in which the currents are not proportional to the charges) of the charge-current commutation rules between arbitrary states and the current-current commutation rules between states of equal momenta can be constructed, given any set of factorizing solutions of the current-current rules. A theorem is proved according to which such factorizing solutions can be obtained from a large class of infinite-component wave equations. (auth)

32644 RELATIVELY COMPACT INTERACTIONS IN MANY PARTICLE SYSTEMS. Combes, J. M. (CNRS, Marseille). Commun. Math. Phys., 12: 283-95(May 6, 1969).

For many-particle relatively compact interactions the essential spectrum of the N-particle Schrödinger Hamiltonian is shown to consist of a continuum $[\Lambda_N, +\infty[$ where Λ_N is the lowest many-body threshold of the system. This result applies in particular to separable interactions and some spin-orbit couplings. The N-particle Green's function is studied with the help of the Weinberg equation for many-body forces whose kernel is shown to be compact in the complementary set of $[\Lambda_N, +\infty[$. (auth)

Electromagnetic

Refer also to abstracts 32598, 32738, 32744, 32805, and 32827.

32645 (DESY-69/17) REMARK ON THE FORM FACTOR IN THE FERMI QUARK MODEL. Meyer, R. F. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1969. 5p. Dep.

It is shown that there are no difficulties in getting a nucleon form factor without zeros from an antisymmetric quark wave function. An example which fits the data very well is given. (auth)

32646 (NP-17842) ANALYSIS OF THE PHOTOPRODUCTION OF π^0 MESONS ON PROTONS IN THE ENERGY RANGE $E_\gamma \leq 1200$ MeV. Pfeil, Walter (Bonn Univ. (West Germany). Physikalisches Institut). 1968. 181p. (In German). Dep.

Thesis. Submitted to Rheinische Friedrich-Wilhelms-Universitaet, Bonn, Ger.

An analysis of the measured cross section for π^0 production on protons is carried out, using the isobar model. The results are compared with the corresponding analysis of π^+ production. The invariant amplitudes $A_i(s,t,u)$, which are calculated with help of the on-mass-shell propagator in the Rarita-Schwinger formalism, are approximated using a pole approximation. Under consideration of the Born approximation, the elementary $\rho-\omega$ exchange, and the selected nucleon resonances P_{33} (1230), D_{13} (1530), F_{15} (1690), P_{33} (1485), D_{15} (1714), S_{31} (1688), and S_{31} (1710), a good description of the data is possible up to $E_\gamma = 1.2$ GeV. The polarization of the recoil nucleons and the asymmetry relations of the interaction cross sections for polarized photons were calculated with the fitted constants and were compared with experiment. Owing to the violation of Watson theorem in the region of the first resonance larger discrepancies were expected here and were observed. The half width $\Gamma_{N^*} - N\gamma$ was calculated from the coupling constant. The ratio of the transition magnetic moment μ_γ of the P_{33} resonance to the SU(6) value $(U_T)_{SU(6)}$ was found to be 1.37 ± 0.14. It is concluded that the isobar approximation, which avoids an exact theoretical basis, yields a good parametrization of the photoproduction. (tr-auth)

32647 (NP-17916) PHOTOPRODUCTION OF PIONS FROM DEUTERIUM IN THE IMPULSE APPROXIMATION. Franzen, G. (Bonn Univ. (West Germany). Physikalisches Institut). Dec. 1968. 106p. (In German). Dep.

The kinematics and interaction cross sections for interactions with three particles in the final state are discussed. A summary is then presented of the nonrelativistic calculation for photoproduction on deuterons in the impulse approximation. The important properties of the photoproduction amplitude on free nucleons are presented. The general structure of the dNN vertex is described, and the analytic behavior of the invariant functions on the dNN vertex and their nonrelativistic limiting case are discussed. The relativistic calculation of the graphs for the $\gamma + d \rightarrow N + N + \pi$ process is discussed. A discussion of numerical results is presented. (L.B.S.)

32648 (NP-tr-1784) BREMSSTRAHLUNG AND THE DETERMINATION OF THE ELECTROMAGNETIC PARAMETERS OF PARTICLES. Zakharov, V. I.; Kondratyuk, L. A.; Ponomarev, L. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by D. L. Allan (Atomic Energy Research Establishment, Harwell, Eng.), from report ITEF-615. 24p. Dep. CFSTI.

The possibility is discussed of determining the multipole moments of particles in processes in which soft γ rays are emitted. It is shown that the magnetic and quadrupole moments of particles with spin 1 and $\frac{3}{2}$ can be found from the angular distribution of the γ rays emitted in the radiative decay of these particles. In addition, for the radiative decay of resonances, it is shown that it is necessary to take into account the emission of γ rays by the initial particles. (auth)

32649 (UR-875-279) TEST OF QUARK MODELS AND ASYMPTOTIC SYMMETRY. Okubo, Susumu (Rochester Univ., N. Y. Dept. of Physics and Astronomy). June 3, 1969. Contract AT(30-1)-875. 28p. (CONF-690607-1). Dep. CFSTI.

From International Conference on Quark Models and Symmetry, Detroit, Mich.

From the study of $\pi^0 \rightarrow 2\gamma$, $\eta \rightarrow 2\gamma$ and $V_\vartheta \rightarrow 1\bar{1}$ decays, it is concluded that the best quark model is that of three-triplet model. Also, some consequences of asymptotic $SU_w(6)$ symmetries are given. (auth)

32650 THREE-PION DECAYS OF THE η-MESON. Lapidus, I. R.; Dutta-Roy, B. (Stevens Inst. of Tech., Hoboken, N. J.). Nuovo Cim., 61A: 449-56(June 1, 1969).

The reduced spectra and sector distribution for the decay mode $\eta \rightarrow \pi^+\pi^-\pi^0$ were calculated using a model in which the s-wave and p-wave pion-pion interactions are dominated by the contributions from the ϵ and ρ mesons. These distributions are determined by a single parameter which also fixes the branching ratio $R = \Gamma(\eta \rightarrow \pi^0\pi^0\pi^0)/\Gamma(\eta \rightarrow \pi^0\pi^+\pi^-)$. A comparison with the predictions of other models for the pion-pion interaction emphasizes the need for improved experimental data which can distinguish nonlinear effects. (auth)

32651 VECTOR DOMINANCE AND FORWARD PHOTOPRODUCTION OF CHARGED PIONS BY POLARIZED PHOTONS. Harari, H.; Horovitz, B. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett., 29B: 314-16(May 26, 1969).

Vector-dominance predicts a relation between the combined asymmetry in π^+ and π^- photoproduction by polarized photons and the cross section for producing transversely polarized vector mesons. It is predicted that at high energies and $t = -m_\pi^2$ this relation will be violated by the data. This expected failure is explained by a strong mass dependence of the mechanism which governs the forward amplitudes for these processes. (auth)

32652 A DISPERSION ANALYSIS OF PION PHOTOPRODUCTION FROM NUCLEONS. I. Jurewicz, A. (Univ., Rome). Z. Phys., 223: 425-40(1969).

An account is given of numerical results for $l = 0$ and $l = 1$ multipole amplitudes of pion photoproduction. They have been obtained by solving integral equations which originate from fixed-angle dispersion relations that have been deduced in an earlier paper. Some difficulties usually encountered in course of solving

the problem of pion photoproduction by dispersion techniques are outlined, and an approach which introduces arbitrary parameters—cutoffs in the integral equation for transition amplitudes is proposed. Numerical results show some implications of this philosophy on the role played by the terms representing physical singularities and terms representing left-hand singularities controlled by one-particle (Born) contributions. (auth)

32653 CURRENT ALGEBRA CALCULATION OF LOW-ENERGY PION PHOTOPRODUCTION FOR PHYSICAL PIONS. Wray, Dennis A. (Oxford Univ.). Nucl. Phys., B11: 27-38 (1969).

Current and field commutators are used to derive Ward identities for the non-pole part of the pion photoproduction amplitude. The assumption that this part of the amplitude is as smoothly varying in the four-momenta as the Ward identities allow then leads directly to predictions for the low-energy photoproduction amplitudes for physical pions. The threshold values of the multipoles thus predicted are compared with the available data. The present calculation reduces to the earlier soft-pion result in the usual limit, but includes also explicit forms and magnitudes for the corrections to the soft-pion limit. (auth)

32654 O(3,1) SYMMETRY AND THE PHOTOPRODUCTION REACTION $\gamma p \rightarrow \pi^+ n$. Raghavan, S.; Samiullah, M. (Osmania Univ., Hyderabad, India). Nucl. Phys., B11: 73-8(1969).

The high-energy reaction $\gamma p \rightarrow \pi^+ n$ was investigated using the formalism of Delbourgo, Salam and Strathdee. To be consistent with this theory the virtual time-like photons were used. A fit was obtained to the experimental data at 2.6 GeV, 2.88 GeV, 3.25 GeV and 4.17 GeV. A conspiracy mechanism for the pion was taken into consideration. The other exchange particle contributing is B. It is found that the sharp forward peak is due to the contribution from the $j_0 = 0$ component of the conspirator amplitude. (auth)

32655 SCATTERING AMPLITUDES IN QUANTUM ELECTRODYNAMICS AT INFINITE ENERGY. Chang, Shau-jin; Ma, Shang-keng (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett., 22: 1334-7(June 16, 1969).

The ee, $e\gamma$, and $\gamma\gamma$ elastic-scattering amplitudes contributed by certain infinite sets of diagrams in the high-energy limit were studied. They were found to be proportional to s, the square of the c.m.-system energy, multiplied by simple combinations of the Glauber forms of high-energy scattering. (auth)

32656 A LOW-ENERGY THEOREM AND NUCLEON–NUCLEON BREMSSTRAHLUNG. Baier, R.; Kuehnelt, H.; Urban, P.; Widder, F. (Univ. of Graz). Acta Phys. Austr., 28: 13-18(1968).

The ratio R of the total cross sections of proton-neutron bremsstrahlung and proton-proton bremsstrahlung is estimated on the basis of the Kroll–Ruderman theorem. A detailed calculation with the one-pion exchange model gives $R \approx 20$, in fair agreement with experiment. (auth)

32657 PION FORM FACTOR AND RHO MESON WIDTH. Roos, Matts (CERN, Geneva); Pisut, Jan. Nucl. Phys., B10: 563-77(1969).

Several different parametrizations of the pion form factor $F_\pi(s)$ are given using either the Omnès function or the N/D method. In order to obtain the ρ resonance parameters all formulas are fitted to data from $e^+e^- \rightarrow \pi^+\pi^-$ colliding beam experiments. The resonance mass, $M_{\rho 0}$, and the width, Γ_0, turn out to be very dependent on the parametrization and the approximations chosen. The most realistic parametrizations lead to a width of $\Gamma_0 = 122^{+4}_{-5}$ MeV and a mass of $M_{\rho 0} = 770 \pm 5$ MeV. Also some comparisons are made with the pion electroproduction data, which give indirect information on $F_\pi(s)$ in the region $s < 0$. (auth)

32658 A MODEL FOR $p\pi^0$ PHOTOPRODUCTION ON PROTONS AND NEUTRONS AT HIGH ENERGIES. Foreyland, Jan (Univ. of Oslo, Blindern, Norway). Nucl. Phys., B11: 204-12 (1969).

A model involving a ω trajectory and a ωP cut—in addition to a ρ trajectory plus a ρP cut found in π^+ and π^- photoproduction—is shown to be able to account for the observed data on π^0 photoproduction on hydrogen above 3 GeV. Predictions are given for π^0 photoproduction off neutrons and for the polarization of the recoil proton. (auth)

32659 THE $\gamma N D_{13}$ COUPLING FROM CURRENT ALGEBRA. Williams, Ruth M. (Univ. of Miami, Florida). Nucl. Phys., B11: 195-203(1969).

The $\gamma N D_{13}(1525)$ coupling is calculated from a saturation at infinite momentum of the algebra of isospin current densities. Parametric transitions are introduced from the states of the saturation to neglected ones, and these parameters are then evaluated by utilizing the detailed knowledge of nucleon electromagnetic form factors. The predicted ratio of the photoproduction cross sections for D_{13} and $N^*(1236)$ agrees well with the experimental value. (auth)

32660 S(3) MODEL FOR BARYON MAGNETIC MOMENTS. Davis, Ronald (Oxford Univ.). Nucl. Phys., B11: 249-51 (1969).

A non-relativistic quark model for baryons enables a simple form of symmetry breaking in magnetic moment calculations through the strange-quark mass difference and an assumption of unit quark gyromagnetic ratio. It leads to good agreement with experiment, and provides a test of the quark model as distinct from abstract SU(3) symmetry. (auth)

32661 ELECTROMAGNETIC MASS AND COUPLING-CONSTANT SHIFTS OF N AND $\Delta(1238)$ IN A BOOTSTRAP MODEL. Lichard, P. (Slovak Technical Univ., Bratislava). Czech. J. Phys., 19: 730-47(1969).

The off-shell reciprocal bootstrap model developed by Biswas and Balázs is used to calculate the mass and coupling-constant shifts of the nucleon and Δ-resonance in a self-consistent way. It is shown that the electromagnetic corrections to the $\Delta N\pi$ coupling constant play a crucial role for obtaining the correct sign of the nucleon mass difference. The effects of mass splittings of exchanged and external particles are also included. The one-photon exchange contributions to the splittings of coupling constants and masses are calculated by means of the Frautschi–Dashen perturbation method. The result of the present calculation $M_p - M_n = 1.8$ MeV is in rough agreement with the experimental value −1.3 MeV. (auth)

32662 ON THE DISPERSION RELATION AND THE SUM RULES FOR THE PION FORM FACTOR. Nguyen Thi Hong (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B11: 127-30(1969).

Some exact sum rules for the pion form factor containing only the modulus of the form factor in the physical regions of the scattering and annihilation channels are obtained. It is shown also that the modulus of the form factor at $t \geq 4m_\pi^2$ can be determined from the data on the scattering cross section ($t \leq 0$). The comparison of this result with the data in the experiment with colliding beams would be a check of the dispersion relation for the pion form factor. (auth)

32663 ELECTROMAGNETIC MASS SHIFTS IN THE PSEUDOSCALAR OCTET. Brown, Laurie M.; Munczek, Herman; Singer, Paul (Northwestern Univ., Evanston, Ill.). Phys. Rev., 180: 1474-6(Apr. 25, 1969).

An effective Lagrangian for pseudoscalar, vector, and axial-vector mesons is used to calculate the electromagnetic mass shifts of pseudoscalar mesons on the basis of vector-meson dominance. It is shown that a previously studied PVV interaction can give a significant negative contribution to $\delta m_{K^+} - \delta m_{K^0}$, at the same time implying an experimentally accessible enhanced decay for $K^{*+} \rightarrow K^+ + \gamma$. On the other hand, the PVV contribution to the pion mass shifts remains small and does not alter the previously obtained good agreement with experiment. (auth)

32664 FORWARD PHOTOPRODUCTION OF π^+ AND K^+ MESONS IN THE REGGE-POLE MODEL. Shih, C. C. (Brookhaven National Lab., Upton, N. Y.); Tung, Wu-Ki. Phys. Rev., 180: 1446-8(Apr. 25, 1969).

High-energy forward photoproduction of π^+ and K^+ are analyzed and compared in the Regge-pole model. It is pointed out that, despite the apparent difference in the shape of the differential cross section for the two processes, existing data are consistent with the exchange of a parity doublet π, π_c or K, K_c as the case may be. The differences arise from the equal and unequal baryon mass kinematics involved in the two cases, respectively. (auth)

32665 INTERACTIONS OF HADRONS WITH NUCLEI AT HIGH ENERGY. II. PHOTOPRODUCTION. Trefil, J. S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 180: 1379-86(Apr. 25, 1969).

The Glauber theory is applied to photoproduction reactions where the final state of the nucleus is not measured. It is found that the theory matches existing data on ρ^0 photoproduction very well. It is shown that $\sigma_{\rho N}$, the ρ-nucleon cross section, can be obtained from these data, and is 25 ± 3 mb. It is argued that in photoproduction of nonvector mesons, similar cross sections can be derived, but that more parameters are involved than in the case of vector mesons. It is predicted that nuclear effects will cause a shift of the central mass in resonance production, and that this shift will depend on the angle of production of the resonance. (auth)

32666 EFFECT OF WEAK INTERACTIONS ON ELECTROMAGNETIC PROPERTIES OF LEPTONS. Choudhury, S. Rai;

Mani, H. S. (Univ. of Michigan, Ann Arbor). Phys. Rev., 180: 1521-4(Apr. 25, 1969).

The electromagnetic properties of leptons in the presence of weak interactions are investigated, using a model essentially similar to the one recently developed by Gell-Mann, Goldberger, Kroll, and Low. It is found that the effect is very small in the anomalous magnetic moment and in the Lamb shift of hydrogen. However, the charge radius of the neutrino turns out to be much larger than the previous estimate of Bernstein and Lee. (auth)

32667 ACCURACY OF RADIATIVE CORRECTIONS TO ELECTROMAGNETIC SCATTERING FROM PROTONS. Campbell, J. A. (Univ. of Texas, Austin). Phys. Rev., 180: 1541-6(Apr. 25, 1969).

Present calculations of radiative corrections for electron-proton and positron-proton scattering usually omit various parts independent of an infrared cutoff in two-photon-exchange contributions to the processes. These parts are examined for their effect on simple calculations which accompany the interpretation of experimental measurements. It is concluded that the simple calculations may not be adequate for large-angle scattering. More detailed and accurate approximations are given for use at such angles if the asymptotic decrease of proton form factors is at least as fast as t^{-2}. A numerical method is outlined for slower decreases. The contribution of the N*(1236) resonance to radiative corrections is noted to depend most strongly on the choice of a form factor for N* photoproduction. (auth)

32668 NUCLEON MASS AND THE GRAVITATIONAL WARD-TAKAHASHI IDENTITY. Bessler, L.; Muta, T.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Phys. Rev., 180: 1604-5 (Apr. 25, 1969).

By using a gravitational Ward-Takahashi identity, some restrictions on the mass form factor are derived which was used by Pagels to calculate the p-n mass difference. It is shown that the result corresponds to his once-substracted dispersion relation for this form factor. (auth)

32669 REMOVAL OF INFRARED DIVERGENCES IN RADIATIVE CORRECTIONS. Kudryavtsev, V. G.; Kalashnikov, N. P.; Ryazanov, M. I. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 56: 1640-3(May 1969). (In Russian).

The effect of multiple coulomb scattering on the radiative corrections to an arbitrary process involving a singly charged relativistic particle and an arbitrary number of neutral particles in the initial and final states is analyzed quantitatively. Removal of infrared divergences in the radiative corrections is investigated in detail. (auth)

32670 ELECTRON IN THE QUANTIZED FIELD OF A MONOCHROMATIC ELECTROMAGNETIC WAVE. Berson, I. (Inst. of Physics, Riga). Zh. Eksp. Teor. Fiz., 56: 1627-33 (May 1969). (In Russian).

The wave function is determined for a system consisting of an electron and the quantized field of a plane monochromatic electromagnetic wave interacting with the electron. Various representations of the wave function obtained are presented and the relation between the wave function and the Volkov solution is discussed. (auth)

32671 SPACE-TIME PICTURE OF γ-QUANTUM SCATTERING BY NUCLEONS AT HIGH ENERGIES. Ioffe, B. L. JETP Lett. (USSR) (Engl. Transl.), 9: 97-9(Jan. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 163-6(Jan. 20, 1969).

The question of the distances that play a role in high-energy scattering processes is clarified experimentally for the case of scattering of virtual γ quanta by nucleons. It is also shown that a space-time picture of the scattering process $\gamma + p \rightarrow \gamma + p$ can be established at small values of the interval $x_\mu^2 = t^2 - x^2$. (L.B.S.)

32672 INELASTIC ELECTRON SCATTERING AT HIGH ENERGIES. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev. Lett., 22: 1409-11(June 23, 1969).

Field-theoretic model calculations for inelastic electron scattering show that (1) scaling laws must be weakly violated; (2) there is no evidence for $\sigma_T/\sigma_S = 0$ or ∞; and (3) the angular spread in production amplitudes must increase as $|Q^2|$ increases and is roughly proportional to $|Q^2|$ for large $|Q^2|$, where Q is the four-momentum of the virtual photon. Some experimental tests are suggested. (auth)

32673 USE OF THE AZIMUTHAL DISTRIBUTION FOR THE ANALYSIS OF COSMIC-RAY JETS. Agnese, A.; La Camera, M.; Wataghin, A. (Univ., Genoa, Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cim., Lett., 1: 705-6(May 11, 1969).

Considering the detector of cosmic ray jets to be an emulsion, stack, the distribution to be expected in the laboratory system and in the cms system is calculated. It is suggested that an experimenter using a plot of the distribution in the (x,y) plane may easily detect the cases in which the fireball is emitted at angles different from 0 or π^0. (J.F.P.)

32674 ELECTRON INTERACTING AS DIPOLE WITH PHOTONS. PHYSICAL CREATION-ANNIHILATION OPERATORS. Eganova, I. A.; Shirokov, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 1097-1109(May 1969). (In Russian).

The model is considered: nonrelativistic electron in an oscillator well interacts as an electric dipole with the quantized electromagnetic field. A corpuscular interpretation of the model is obtained that differs from the conventional interpretation ("bare particles"). The vacuum state for the new photon creation annihilation operators coincides with the physical vacuum. The process "the oscillator has been excited and emits a physical photon" is absent even as a virtual one. There is an indication to that in case of the local interaction after the physical operators are introduced no divergences appear in the theory.

32675 COMPTON SCATTERING OF γ QUANTA ON DEUTERONS. Alimov, A. D. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 56-60 (1969). (In Russian).

Elastic scattering of γ quanta on deuterons at an angle of 0° and energies of 100 to 350 MeV was studied to investigate the effects of nucleon motion in the deuteron using the relativistic impulse approximation of Cutkosky. (C.E.S.)

32676 VACUUM MAGNETIC MOMENT OF AN ELECTRON MOVING IN A HOMOGENEOUS MAGNETIC FIELD. Ternov, I. M.; Bagrov, V. G.; Bordovitsyn, V. A.; Dorofeev, O. F. (Moscow State Univ.). Izv. Vyssh Ucheb. Zaved., Fiz., No. 11, 17-22 (1968). (In Russian).

Using the methods of quantum electrodynamics, the relation of the electron vacuum magnetic moment with the electron energy and with the intensity of the magnetic field is studied. This relation turns out to be most essential in the case of strong magnetic fields. For an ultrarelativistic electron the vacuum magnetic moment turns out to be dependent upon the energy of the electron and also on the weak magnetic field. (tr-auth)

32677 QUANTUM THEORY OF A RADIATING CHARGED PARTICLE MOVING IN A MAGNETIC FIELD AND IN A PLANE WAVE. Ternov, I. M.; Bagrov, V. G.; Khalilov, V. R. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 11, 102-7 (1968). (In Russian).

Using the methods of quantum theory a radiating charged particle which moves in a constant magnetic field and in a plane wave which travels along the magnetic field is considered. (tr-auth)

32678 POLARIZATION OF THE RECOIL DIRAC PARTICLE IN THE COMPTON SCATTERING OF POLARIZED PHOTONS. Kukanov, A. B.; Amer, A. A. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 21-4(1968). (In Russian).

The scattering of elliptically polarized quanta on a point nonpolarized Dirac particle initially at rest and having charge and its own anomalous magnetic moment was examined. An expression was obtained for the differential effective scattering cross section; and the longitudinal polarization of the recoil Dirac particle was studied. (tr-auth)

Weak

Refer also to abstracts 32125, 32649, and 32809.

32679 (COO-1545-56) SUPPRESSION OF STRANGENESS CHANGING WEAK CURRENTS AND THE BOOTSTRAP EQUATION. McClelland, J. A. (Ohio State Univ., Columbus. Dept. of Physics). June 1969. Contract AT(11-1)-1545. 31p. Dep. CFSTI.

An approximate solution to the c-number bootstrap equations $a_i = cd_i^{jk}(a_j a_k + b_j b_k)$, $b_i = ed_i^{jk}a_j b_k$, is obtained for $e \neq 2c$, where the amplitudes a_i and b_i represent the matrix elements of unitary octet vector and axial vector currents, respectively, d_i^{jk} is the completely symmetric invariant tensor of the third order, the unitary spin indices run from 1 to 8, c is an arbitrary constant, and e-2c is small. The nature of this solution suggests a second approach for finding approximate solutions which are more general, and for easily analyzing the effects on previous exact solutions (for $e = 2c$) of assumptions made in their derivation. In the approximate solutions, the zero order terms are the size of the electromagnetic charges, the first order terms are the size of

the weak currents, and second order terms are calculated. The second approach is used for $e \neq 2c$. The bootstrap equations for $e \neq 2c$ are much more restrictive than for $e = 2c$. The approximate solutions are not however more restrictive on the Cabibbo angle. They restrict the relative sizes of the currents to values which are physically uninteresting. It is concluded that the solution which most likely describes the actual physical situation most closely is an approximate solution that was listed in the Appendix of a previous paper for $e = 2c$. The physical consequences of this solution are discussed in more detail. (auth)

32680 POSSIBLE CONTRIBUTIONS OF $\Delta S = -\Delta Q$ AMPLITUDES TO K^0_{l3} DECAY RATES. Field, J. H. (Rutherford High Energy Lab., Chilton, Eng.). Nuovo Cim., 61A: 532-40(June 1, 1969).

General expressions are given for the lifetime distributions of the positive and negative leptons in the $\pi^{\pm}l^{\mp}\nu$ decay modes in a neutral-kaon beam of known initial strangeness. For K^0_{l3} decays the contribution of a possible violation of $\Delta S = \Delta Q$ in the f_- form factor is included. The K^0_S, K^0_L interference region and the K^0_L decays are considered separately. Experimental methods of determining the two complex, Lorentz invariant, $\Delta S = -\Delta Q$ amplitudes, x_+ and x_- are discussed. (auth)

32681 A METHOD OF CALCULATING THE AXIAL VECTOR CURRENT COUPLING CONSTANT FOR LEPTONIC DECAY OF BARYONS. Au-Yang, Man Keung. Berkeley, Calif., Univ. of California, 1968. 56p.

Thesis.

Based on the usual PCAC and current algebra assumptions together with the assumption that the BBM vertex function vanishes as the four momentum squared of one of the baryons is "dispersed" to infinity, it is shown that the classic SU(6) and current algebra results for the axial vector current coupling constant—G_A = 5/3 and F/D = 2/3—are the unrenormalized values. The renormalized values are then expressed in terms of the unrenormalized values and certain "side-wise dispersion integrals" analogous to those introduced by Bincer, Drell and Pagels. A rough estimation of these integrals, using a purely theoretical method in which the only experimental numbers are the physical masses and the pion—nucleon coupling constant gives $G_A = 1.22$. The method is general and can be applied to other leptonic decay of baryons, two of which are also considered and the results agree well with experiment. (Disser. Abstr.)

32682 POSSIBILITY OF DETECTING THE W BOSON BY MEANS OF THE POLARIZATION OF THE MUONS FROM THE $W \rightarrow \mu + \nu$ DECAY. Bunatyan, G. G.; Dobretsov, Yu. P.; Dolgoshein, B. A.; Zhizhin, E. D.; Kirillov-Ugryumov, V. G.; Nikitin, Yu. P. JETP Lett. (USSR) (Engl. Transl.), 9: 192-4(Mar. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 325-8(Mar. 5, 1969).

A different method is proposed for identifying the W boson among the NN interaction products by means of the sign of the longitudinal polarization of the muons from $W \rightarrow \mu\nu$ decay. The setup for an experiment which uses a 70 GeV proton beam is discussed. (L.B.S.)

32683 $K_S - K_L$ REGENERATION AMPLITUDE IN COPPER AT 2.5 GeV/c AND PHASE OF η_+. Bennett, S.; Nygren, D.; Saal, H.; Steinberger, J.; Sunderland, J. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 29B: 317-20(May 26, 1969).

Reported data for the time dependent charge asymmetry in the K_{e3} mode and the relative $\pi^+\pi^-$ rate following a copper regenerator were reanalyzed. For the $K_L - K_S$ regeneration amplitude at 2.5 GeV/c, the phase $\phi_f = \arg[i(f - \bar{f})/p] = (-49.9 \pm 5.4)^0 - 95^0 \times (\Delta m/\Gamma_S - 0.469)$ and $|f - \bar{f}|/p = (2.55 \pm 0.15) \times 10^{-26}$ cm^2. Combining our result for ϕ_f with measurements of the 2π interference phase $\phi_+ - \phi_f$, the phase of the CP violating parameter η_+: $\phi_+ = (37.1 \pm 7.1)^0 + 104^0 \times (\Delta m/\Gamma_S - 0.469)$. Denoting by x the ratio of $\Delta S = \Delta Q$ rule violating to conserving amplitudes, it is found that $(1 - |x|^2)/|1 + x|^2 = (0.96 \pm 0.05)$, consistent with no violation. (auth)

32684 EFFECTS OF PHOTON EXCHANGE IN BETA-DECAYS. Tint, M. (International Centre for Theoretical Physics, Trieste, Italy); Yap, C. T. Phys. Lett., 29B: 289-90(May 26, 1969).

It is shown that, according to the conserved vector current theory, photon exchange effects do not contribute in β-decays. (auth)

32685 REMARKS ON K_{l3} FORM FACTORS. Greenberg, David F. (Carnegie—Mellon Univ., Pittsburgh). Nucl. Phys., B11: 131-8(1969).

Several simple models for K_{l3} form factors are studied in the context of current algebra and dispersion relations. Results are compared with other theoretical work and with experiment. (auth)

32686 K_{l3} FORM FACTORS FROM CURRENT ALGEBRA AND THE RELATIVISTIC QUARK MODEL. Boehm, M.; Rein, D. (Univ., Wuerzburg, Ger.). Nucl. Phys., B11: 61-8(1969).

Using the relativistic quark model for the description of pseudoscalar meson states and the charge commutation relations of current algebra, several form factors of current matrix elements are determined for zero and time-like values of momentum transfer. The results of our calculations are found to be in good agreement with recent experimental data on the absolute values and the energy dependence of the form factors of K_{l3} decay. In addition, the knowledge of the relevant form factors enables the quadratic Gell—Mann—Okubo mass formula to be derived for the pseudoscalar mesons in a more direct manner. (auth)

32687 THE FORM FACTORS FOR K_{l3} DECAYS. Kenny, B. G.; Oades, G. C. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B11: 222-30(1969).

Following the original dispersion relation approach of McDowell, the limits that can be placed on the K_{l3} form factor parameters, $\xi(0)$, λ_+, and λ_- are found, if reasonable assumptions are made about the behavior of these decay form factors in their unphysical region. (auth)

32688 CONTRIBUTIONS FROM HIGHER MASS STATES TO KAELLEN'S TREATMENT OF RADIATIVE CORRECTIONS TO β-DECAY. Gustafson, Goesta (Univ. of Lund, Sweden). Nucl. Phys., B11: 213-21(1969).

In a paper by Källén an attempt was made to estimate the radiative corrections to β-decay. Here, the influence of intermediate states with higher masses, as e.g., states with one nucleon and one or more pions or kaons, are neglected. In this paper an attempt is made to test this approximation by estimating the contribution from some of these terms, viz., those where the intermediate state is a resonance N*(1236). The result is that the contribution from these states is of the same order of magnitude as the estimated error in the terms which Källén calculated. (auth)

32689 HARD-MESON CURRENT ALGEBRA ANALYSIS OF THE K_{l3} DECAY. Arnowitt, R.; Friedman, M. H.; Nath, P. (Northeastern Univ., Boston). Nucl. Phys., B10: 578-96(1969).

A hard-meson calculation of the K_{l3}, K^*, and κ decays is given based upon chiral SU(3) × SU(3) current algebra, pion and kaon PCAC, single meson saturation, approximation of meson vertices by low-order polynomials in momentum. No a priori assumption on the size of SU(3) or chiral breakdown, or type of chiral breakdown, is made. The possible existence of a κ-meson is included by the PCVC condition on the strangeness changing vector current. If $f_+(0)$ takes on its SU(3) symmetric value ($f_+(0) \approx 1.0$) then large breakdown of chiral invariance exists, while the chiral symmetric value ($f_+(0) \approx 0.86$) implies large breakdown of SU(3). A value of λ_+ consistent with the K_{l3} data and yielding also the correct K* width if one uses the chiral symmetric $f_+(0)$ can be obtained, and implies the vanishing of the K*-K-π vertex asymptotically. If no κ-meson exists, the theory requires both $|\xi|$ and λ_- to be small. This is also generally the case if a κ meson exists and one assumes a (3*,3) + (3,3*) form of chiral breakdown. A large $|\xi|$ and small λ_- (which is consistent with both the polarization and the most recent branching ratio determinations) can only be achieved if both a κ-meson exists and one violates the (3*,3) + (3,3*) assumption. The theory also predicts a κ width in agreement with recent data. It is further shown that the hard meson assumption are inconsistent with both a large $|\xi|$ and a large λ_-, and that the Gallan—Treiman relation may be in error by as much as 50% (due to the presence of nongentle terms in the K_{l3} amplitude). (auth)

32690 NEUTRON BETA DECAY IN A UNIFORM CONSTANT MAGNETIC FIELD. Matese, J. J.; O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Phys. Rev., 180: 1289-92(Apr. 25, 1969).

The β-decay rate of a polarized neutron source in a constant, uniform magnetic field of arbitrary strength is calculated. It is shown that the decay rate is substantially changed if the magnetic field is of order 10^{15} G or larger. Fields of such strength have been speculated to exist in the early universe or in neutron stars. (auth)

32691 SPIN AND ORBITAL MOTIONS OF A PARTICLE IN A HOMOGENEOUS MAGNETIC FIELD. Henry, G. R.; Silver, J. E. (Stanford Univ., Calif.). Phys. Rev., 180: 1262-3 (Apr. 25, 1969).

The spin and orbital motions of a particle in a homogeneous magnetic field are examined in a classical approximation. Application is made to the determination of the g-factor anomalies of the electron and muon. It is found that the experimentally observed difference frequency between the spin and orbital motions depends on the component of particle velocity parallel to the

magnetic field, and is proportional to $(1 - v_s^2/c^2)^{1/2}$, where the magnetic field defines the z axis. (auth)

32692 NEUTRINO-PAIR BREMSSTRAHLUNG FROM A DEGENERATE ELECTRON GAS. Festa, George G. (City Univ. of New York, N. Y. New York Univ., N. Y.); Ruderman, Malvin A. Phys. Rev., 180: 1227-31(Apr. 25, 1969).

Neutrino-pair bremsstrahlung is calculated for a hot degenerate electron gas Coulomb scattering on imbedded nuclei in all regimes of possible astrophysical interest. Effects of possible lattice structure among nuclei are included. In the limit of infinite densities where the electrons are very relativistic, the power radiated per unit mass is about 0.8 $(T \times 10^{-8})^6 Z^2/A$ erg/g sec, independent of density. Therefore, such bremsstrahlung is the dominant neutrono-pair emission process in the high-density limit. (auth)

32693 TIME-REVERSAL INVARIANCE IN SEMILEPTONIC WEAK PROCESSES. Kim, C. W. (John Hopkins Univ., Baltimore); Primakoff, H. Phys. Rev., 180: 1502-5(Apr. 25, 1969).

It is shown that no unambiguously interpretable experimental evidence is now available for the time-reversal invariance of the semileptonic weak Hamiltonian. Several experiments, decisive in this regard but as yet unperformed, are treated briefly. (auth)

32694 THEOREM ON THE FORM FACTORS IN K_{l3} DECAY. Dashen, Roger; Weinstein, Marvin (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett., 22: 1337-40(June 16, 1969).

A formula is derived for the matrix element $\langle K|\partial_\mu F_\xi^\mu|\pi\rangle$ correct up to second order in both the momentum transfer t and the breaking of SU(3) ⊗ SU(3) symmetry. This leads to a prediction that ξ is very small compared with unity. The result is independent of any assumption concerning the structure of the symmetry-breaking Hamiltonian. (auth)

32695 ON A MODEL OF RENORMALIZABLE WEAK INTERACTION. Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1050-9(May 1969). (In Russian).

Model of renormalizable weak interaction, formulated by Kummer and Segre for leptonic interactions, is generalized to hadron-lepton and nonleptonic processes. Using the method analogous to the current algebra it is shown that the theory results in equality of vector coupling constants of neutron and muon decays. A new solution of the problem of neutral currents is presented and a criterion of applicability of the theory to nonleptonic weak interactions is formulated. The model does not contradict to the experimental data and has no difficulties of the conventional theory at high energies. Experiments to test the theory are proposed. (auth)

Strong (General)

Refer also to abstracts 32645, 32649, and 32835.

32696 (JINR-P2-4418) QUARK MODEL WITH NON-EVEN QUARK MASSES. Bogolubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 8p. (In Russian). Dep.

A dynamic quark model with noneven quark masses was considered on the basis of the equation of Bethe-Salpeter type. The mass formulas were obtained. (auth)

32697 RESONANT SOLUTIONS OF THE LOW EQUATION FROM FIXED-POINT THEOREMS. McDaniel, H. (Illinois Inst. of Tech., Chicago); Warnock, R. L. Phys. Rev., 180: 1433-45 (Apr. 25, 1969).

Fixed-point theorems are used to prove the existence of a class of solutions to the one-meson Low equation of the static-baryon model. The main result is that there exist solutions involving an arbitrary choice of narrow resonances. This is true for any crossing matrix with a finite number of channels, and for any cutoff function of a large class. For sufficiently small coupling constants, the solutions can be constructed by a convergent iteration procedure. The stable particles and the arbitrarily chosen resonances are associated with Castillejo-Dalitz-Dyson poles of an appropriate denominator function. The methods used do not suffice to show that solutions of the bootstrap type exist. Our earlier work is improved in that resonances are allowed and a bigger range of coupling constants and a weaker cutoff are permitted. The analysis is based on a crossing-symmetric N/D formulation of the Low equation. (auth)

32698 CHIRAL DYNAMICS WITHOUT A_1. Petito, J. M. (City Univ. of New York, N. Y.). Phys. Rev., 180: 1395-1402 (Apr. 25, 1969).

The nonlinear realization method of Weinberg is used to construct a chiral-invariant Lagrangian consisting of π, N, N*(1236), and ρ, but not A_1. Chiral invariance can be, of course, maintained without invoking the A_1 meson. In view of the experimental status of A_1, it may be worthwhile studying such a model. The tree-diagram technique is used, with an off-mass-shell N* propagator, to calculate pion-nucleon s-wave scattering lengths, isobar production parameters, and single-pion photoproduction differential cross sections. A comparison with the current-algebra method is made. (auth)

32699 MULTIPERIPHERAL DYNAMICS AT ZERO MOMENTUM TRANSFER. Chew, Geoffrey F.; De Tar, Carleton (Univ. of California, Berkeley). Phys. Rev., 180: 1577-82(Apr. 25, 1969).

Following a suggestion by Goldberger and Low, the crude multi-Regge bootstrap model of Chew and Pignotti is reformulated through a generalization of the physical-region integral equation discovered in 1962 by Fubini and collaborators. When consideration is restricted to zero momentum transfer, Lorentz symmetry permits almost complete diagonalization of the kernel, Lorentz poles corresponding to eigenvalues thereof. Cuts also appear but in a manner dynamically and unambiguously related to the poles. Being an expression of unitarity, the equation encompasses "absorptive" effects. (auth)

32700 VANISHING OF TOTAL CROSS SECTIONS AT INFINITE ENERGY. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Contract N00014-67-A-0298-0005. Phys. Rev. Lett., 22: 1405-8(June 23, 1969).

The scattering amplitude of two scalar particles in scalar electrodynamics was examined for arbitrary order of perturbation, and uncanceled terms were found proportional to $s(\ln s)^n$, for n any positive integer. This suggests a branch point or an essential singularity at J = 1, and that total cross sections vanish at infinite energy as some negative power of ln s. This form fits very well the sum of the measured π^+p and π^-p cross sections between 8 and 22 BeV/c. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 32689, 32796, 32844, and 32845.

32701 UNITARITY AND FINITE-ENERGY SUM RULES. Arbab, Farzam. Berkeley, Calif., Univ. of California, 1968. 41p.

Thesis.

Unitarity, analyticity, Regge asymptotic behavior, and a resonance approximation are combined to derive a new sum rule. The sum rule is very convergent; the contribution of high-mass resonances is suppressed by a decreasing weight function. The spin-flip and nonspin-flip residues of the ρ meson in the $\pi\pi \to N\bar{N}$ amplitude are evaluated at the mass of the ρ, and in conjunction with the first-moment finite-energy sum rule a calculation of the ρ-meson mass is performed. The results are in good agreement with experiment. The sum rule is then applied to the calculation of the ρ and f_0 resonance parameters in the $\pi\pi \to \pi\pi$ amplitude. A discussion of the behavior of the sum rule near the elastic threshold is also included. This discussion may give some insight into the nature of the approximations involved in the derivation of the sum rule. (Disser. Abstr.)

32702 TRANSVERSALITY OF FIELDS OF VECTOR AND AXIAL-VECTOR MESONS AND HELICITY SYMMETRIES. Chkareuli, Dzh. L. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.), 9: 189-92(Mar. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 321-4(Mar. 5, 1969).

The connection between the condition of the transversality of the fields of V and A mesons with helicity symmetries is established on the basis of the Lagrangian formalism. It is shown that in theories in which the V and A fields remain transverse also in the interaction, a helicity group arises and moreover the field algebra is satisfied. (L.B.S.)

32703 A REMARK ON THE COUPLING OF THE ρ TRAJECTORY TO THE π-π SYSTEM. Antoniou, N. G. (Univ., Tuebingen, Ger.). Z. Phys., 223: 441-6(1969).

A finite energy sum rule for the π-π scattering suggests that the ρ-trajectory chooses nonsense at the point $\alpha_\rho = 0$, and that the spin of the g(1650) meson is $J^P = 1^-$. (auth)

32704 MODEL CALCULATIONS FOR I = 0 AND I = 2 S-WAVE PION-PION SCATTERING. Kretzschmar, Martin (Florida State Univ., Tallahassee). Z. Phys., 223: 397-414(1969).

Several simple models for the S-waves in isospin I = 0 and I = 2 pion-pion scattering are constructed. These models are based on unitarity, analyticity in the complex q-plane (q = cm momentum),

approximate crossing symmetry, and the assumption that the forces acting in the S-waves are mainly due to exchange of ρ-mesons, f-mesons and a strong I = 0 S-wave. These models contain between one and three parameters, which are being used to obtain a best fit to Walker's I = 0 data. Best fits are associated with an I = 0 scattering length $a_0 = 0.53\ \mu^{-1}$. Having fixed the parameters from the I = 0 data, predictions are obtained for the I = 2 S-wave. The predictions are generally characterized by a very small positive I = 2 scattering length $a_2 \lesssim 0.08\ \mu^{-1}$ and a zero of the phase shift just above threshold, at a total cm energy of 320 to 360 MeV. The cause for this behavior is shown to be the strong S-wave in the crossed I = 0 channels. Various reasons are discussed, why this zero might be expected to occur at somewhat larger or at smaller energies, even below threshold. Although because of the crudeness of these models the significance of the results is mainly qualitative, certain internal contradictions in the Walker data seem to be indicated. (auth)

32705 POSITIVE MASS DISTRIBUTION IN THE NON-LINEAR SPINOR THEORY. David, J. H. Bull. Cl. Sci., Acad. Roy. Belg., 54: 1244-61(1968).

Defining generalized functions products by analytic continuation, a two-point function whose mass distribution is positive may be used in the nonlinear spinor theory. As an application, it is shown that in an approximation where only strong interactions are considered—so that no imaginary parts have to be neglected, correct values for the π and η meson masses (and eventually, using enough parameters, for the meson nucleon coupling constants) may be obtained, in the first order of the new Tamm–Dancoff method, if the mass distribution is positive; if not, it seems that the contribution of the negative part must be negligible. (auth)

32706 MASS FORMULAS FOR MESON NONETS. Votruba, J. (Inst. of Physics, Prague); Havlicek, M. Czech. J. Phys., 19: 721-9(1969).

General mass formulas corresponding to irreducible nonet representations of the Formánek infinite dimensional Lie algebra $A(P,SU_3)$ are derived and compared with experimental data in cases of 0^-, 1^-, 1^+, and 2^+ meson nonets. (auth)

32707 CONSISTENCY CONDITIONS IN CURRENT ALGEBRA AND THE EXISTENCE OF THE σ-MESON. Nasrallah, N. F. (Middle East Technical Univ., Ankara). Nucl. Phys., B11: 240-8 (1969).

A study of the π-π scattering amplitudes and of the so-called σ-term leads to current algebra consistency conditions which seem to require the existence of a σ-meson. The effect of such a meson on π-π scattering is studied. Solutions obtained for the scattering lengths are in excellent agreement with the latest experimental determination from K and η decays. (auth)

32708 THE DEGENERACY AND THE RECURRENCE OF REGGE TRAJECTORIES IN VENEZIANO'S MODEL. Lacaze, Robert (Institut de Physique Nucleaire, Paris); Nicolescu, Basarab. Nucl. Phys., B11: 55-60(1969).

Some consequences of Veneziano's supplementary conditions are studied for a large class of processes. In particular, the necessity of the introduction of the f', ρ_N, and ρ_N' trajectories is noted. The use of Adler's self-consistency conditions in the model is also discussed. (auth)

32709 O(3,1) SYMMETRY AND THE CHARGE EXCHANGE REACTION $\bar{p}p \to \bar{n}n$. Samiullah, M. (Osmania Univ., Hyderabad, India); Rao, A. Srinivas. Nucl. Phys., B11: 69-72(1969).

The high-energy behavior of the charge exchange reaction $\bar{p}p \to \bar{n}n$ is analyzed within the context of the O(3,1) symmetry formalism. A good fit to the experimental data is obtained if the exchanged particles are chosen to be ρ, ρ', and A_2. It is found that the dominant contribution of ρ and A_2 is from the helicity non-flip amplitudes while the contribution of ρ' is purely from the helicity flip amplitude. (auth)

32710 THE WIDTH OF THE RHO MESON AND THE CHOICE BETWEEN DIFFERENT LOCAL CURRENT ALGEBRAS. Saperstein, Alvin M. (Wayne State Univ., Detroit). Nucl. Phys., B11: 21-6(1969).

A calculation of the rho width is given which does not assume zero mass for the rho and whose results depend upon the local current algebra. The results seem to favor the quark algebra over the algebra of fields. (auth)

32711 DUALITY AND THE IDENTIFICATION OF RESONANCES. Collins, P. D. B.; Ross, G. G.; Squires, E. J. (Univ. of Durham, Eng.). Nucl. Phys., B10: 475-80(1969).

It is shown that the Argand loops obtained from the Veneziano formula do not coincide with the resonance poles of that formula. Since the Veneziano model satisfies duality it is concluded that even if duality were true Argand loops would not provide an adequate means for the location of resonances. (auth)

32712 A MODEL FOR S-WAVE PION–PION SCATTERING FROM ANALYTICITY, UNITARITY, AND CROSSING SYMMETRY. Bonnier, B. (Institut de Physique Nucleaire, Paris). Nucl. Phys., B10: 467-74(1969).

A model for I = 0 and I = 2 S-wave pion–pion scattering is constructed on the basis of the dispersion relations for the inverse partial amplitudes. It fulfills rigorous constraints from analyticity, unitarity and crossing. It agrees well with experimental knowledge. (auth)

32713 GENERALIZED VENEZIANO MODEL WITH ISOSPIN. Paton, J. E. (Oxford Univ.); Chan, Hong-Mo. Nucl. Phys., B10: 516-20(1969).

A generalization of the Veneziano model to the N-point function was proposed which was crossing symmetric and bootstrap consistent in treating all particles as bound states of others. However, the model was so far limited to only neutral mesons. A very simple general method for incorporating isospin into the model which preserves all the desirable properties and gives no unwanted states of high isospin is proposed. Previously known results for the four and five point functions appear as special cases of the solution. (auth)

32714 DECAY RATES OF MESON RESONANCES IN A QUARK MODEL. Micu, L. (Inst. for Atomic Physics, Bucharest). Nucl. Phys., B10: 521-6(1969).

Assuming a quark-antiquark structure with L excitation for the meson resonances the decay rates of spin 2^+, 1^+, and 0^+ mesons are calculated in a quark rearrangement model. The results are in satisfactory agreement with the experimental data. (auth)

32715 HOW GOOD ARE THE HARD-PION CALCULATIONS NEAR THE A_1 MASS? Horwitz, Paul; Roy, Probir (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 180: 1430-3(Apr. 25, 1969).

The possibility of relaxing the smoothness assumption in the hard-pion treatment of the $A_1\rho\pi$ system is examined. The assumption of single-meson dominance of the propagators is retained and the Bjorken limit is imposed on the primitive vertex function. When the relevant commutators are evaluated in the algebra of fields, a single new parameter is introduced. It is found that the data on the ρ spin correlation can only be fitted by an A_1 width somewhat lower than the currently accepted one. (auth)

32716 SELF-CONSISTENT REGGE TRAJECTORY IN A MULTIPERIPHERAL MODEL. Caneschi, L.; Pignotti, A. (Univ. of California, Santa Barbara). Phys. Rev., 180: 1525-31(Apr. 25, 1969).

The possibility of using multiparticle unitarity to write self-consistency equations for Regge trajectories is examined. On the assumption that the dominant mechanism for inelastic processes at high energy is provided by multi-Reggeized meson exchange, and using the integral-equation approach suggested by Chew, Goldberger, and Low, the self-consistency conditions on the trajectory intercept and slope leave only one free parameter. The numerical values obtained are physically quite reasonable. It is also possible to generate the Pomeranchuk trajectory via the same dynamical mechanism. The slope of the Pomeranchuk trajectory thus obtained is similar to the slope of the meson Regge trajectory. (auth)

32717 EIGENPHASE SHIFTS AND DOUBLE-HUMPED RESONANCES. Rosdolsky, Hans (Univ. of Oregon, Eugene). Phys. Rev., 180: 1403-4(Apr. 25, 1969).

Using eigenphase shifts, it is shown how a resonance can be single-humped in some reactions and double-humped in others, as appears to happen for the A_2. (auth)

32718 CROSSING-SYMMETRIC REGGE MODEL AND ISOVECTOR MESON DECAYS. Frampton, P. H. (Univ. of Chicago). Phys. Rev., 180: 1392-4(Apr. 25, 1969).

Some features of a Regge model due to Veneziano are investigated. First, it is stated generally which subsidiary trajectories occur when one keeps only the leading-order term; second, by assuming that the A_{2L} meson is on a subsidiary trajectory, an inequality concerning the $\pi\eta$ and $\pi\rho$ decay modes of A_{2L} and A_{2H} mesons is derived; third, the decay widths for the first Regge recurrence of the ρ meson are studied. (auth)

32719 FERMION QUARKS OF SPIN ½. Franklin, Jerrold (Temple Univ., Philadelphia). Phys. Rev., 180: 1583-7(Apr. 25, 1969).

The usual quark model of baryons requires quarks to obey effective Bose statistics if they are to be in space-symmetric states. It is shown that if quarks had spin ½ they could obey the usual Fermi statistics, even with space-symmetric wave

functions. Using spin-$\frac{1}{2}$ quarks, a completely antisymmetric three-quark state of total spin $\frac{3}{2}$ corresponding to the baryon decuplet, and a mixed symmetry state of total spin $\frac{1}{2}$ corresponding to the baryon octet were constructed. A simple dynamical assumption about the spin dependence of quark-quark forces limits the s-wave baryon states to the octet and decuplet, and saturates the quark binding at three. Very little difference was found in the experimentally tested quark-model predictions when spin-$\frac{1}{2}$ quarks are used. The main differences found are: the well-known prediction that $-\mu_p/\mu_n = \frac{3}{2}$ is lost with spin-$\frac{1}{2}$ quarks, and they must have anomalous magnetic moments. The predicted Σ^+ moment is essentially unchanged, but the Ξ^- and Ω^- moments change when spin-$\frac{1}{2}$ quarks are used, and their measurement would test the spin of the quark. With spin-$\frac{1}{2}$ quarks, mass relations within SU(3) multiplets are kept while the less well satisfied relations connecting octet to decuplet mass differences get broken by a small amount. (auth)

32720 CROSSING SYMMETRY, CURRENT ALGEBRA, AND THE KAWARABAYASHI–SUZUKI–RIAZUDDIN–FAYYAZUDDIN RELATION. Kamal, A. N. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 180: 1454-6(Apr. 25, 1969).

The implications of crossing symmetry and current algebra on the KSRF relation were investigated. (auth)

32721 HARD-PION RESULTS FROM THE ALGEBRA OF FIELDS. Brown, Stanley G. (Massachusetts Inst. of Tech., Cambridge); West, Geoffrey B. Contract AT(30-1)-2076. Phys. Rev., 180: 1613-15(Apr. 25, 1969).

The "hard-pion" calculations for the $A\rho\pi$ system are reexamined with the smoothness hypothesis replaced by the use of the Bjorken limit and the algebra-of-fields current commutators. The new results contain one additional parameter which affects only the transverse $A\rho\pi$ coupling, and are in better agreement with experiment. It is pointed out that it is impossible to combine the quark-model commutation relations with these hard-pion methods. (auth)

32722 SUPPRESSION OF $A_2 \rightarrow K\bar{K}$ IN THE VENEZIANO MODEL. Goldberg, H.; Srivastava, Y. (Northeastern Univ., Boston). Phys. Rev. Lett., 22: 1340-2(June 16, 1969).

Relations between coupling constants derived from the Veneziano amplitude for $\pi K \rightarrow \rho K$, combined with a previous result, allow us to predict the (observed) suppression of the $K\bar{K}$ decay mode of the A_2 meson. (auth)

32723 VENEZIANO MODEL AND $\pi\rho$ SCATTERING. Costa, G. (Univ., Padau. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., Lett., 1: 665-8(May 11, 1969).

The possibility of writing a simple Veneziano-type formula for the amplitude D(s,t) is shown for $\pi + \rho$ scattering. It is noted that the scattering lengths for this process are completely determined by the D amplitude. (J.F.P.)

Strong (Baryon No. = 1)

Refer also to abstracts 32619, 32645, 32665, and 32796.

32724 (DESY–69/16) MULTIPARTICLE EXCHANGES, SU(3) SYMMETRY BREAKING, AND THE $3/2^+$ RESONANCE SPECTRUM. Katz, J.; Wagner, S. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr. 1969. 53p. Dep.

The multi-channel relativistic Schrödinger equation is solved for the $\frac{3}{2}^+$ partial-wave amplitude with a potential obtained by computing the baryon exchange contribution to pseudoscalar meson-baryon scattering. The extrapolation of the potential off the mass shell is done in such a way that both initial and final particles are treated symmetrically. In addition the replacement $a_0 + b_0 + c_0 + d_0 \rightarrow 2\sqrt{s}$ is made, where a_0, c_0, b_0, and d_0 denote the energies of the mesons and baryons respectively and $\sqrt{s}$ the total energy of the system. In this way an energy dependent potential is obtained and instead of introducing a cutoff parameter the coupling constant is used as an adjustable parameter. Thus $g^2/4\pi = 38$ is taken in order to obtain the N*(1236) at the correct experimental energy. The model yields the usual $\frac{3}{2}^+$ decuplet and predicts in addition the existence of a $\underline{27}$ dimensional SU(3) representation (to which $P_{33}(1690)$, $P_{13}(1860)$, $Z_1(1900)$ and some higher Σ, Ξ, and Λ resonances could belong) as well as a second decuplet at much higher energies. Certain resonances ("exotic" ones with I = 2, Y = 0; I = $\frac{3}{2}$, Y = –1; and I = 1, Y = –2) are very broad (>1000 MeV); others (the usual ones including the exotic I = 1, Y = 2 KN resonance) have a width $\lesssim$400 MeV. The dependence of the resonance spectrum on the breaking of SU(3) symmetry as well as on the coupling constant and on the F/D ratio is discussed. A value of the F/D ratio of about 0.4 seems to fit best to experiments. The results are compared with the $\frac{3}{2}^+$ predictions of other models such as N/D calculations, quark model, strong coupling theory and SU(3)'' symmetry. In the latter two models a 27 appears also as a higher supermultiplet, which is forbidden in the quark model. Additional octets and $\overline{10}$ representations (predicted also by the SU(3)'' and the quark model) are obtained as unphysical objects in our calculation. (auth)

32725 (ITF-69-22) TWO-CHANNEL CALCULATION OF P_{11} RESONANCE IN THE πN RESONANCE. Lend'el, V. I.; Marina, D. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 9p. (In Russian). (CONF-690417-2). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Within the framework of the two-channel method the P_{11} wave of πN-scattering is calculated. For the second channel the $\bar{G}N \rightarrow GN$ channel is used. The obtained solution has all the properties of a P_{11}-wave. Existence of the solutions is provided taking account of short wave repulsion. (auth)

32726 RHO-BOOTSTRAP AND PION–NUCLEON SCATTERING IN OPTIMAL DETERMINANTAL APPROXIMATION. Ong, Kwok Maw. Berkeley, Calif., Univ. of California, 1968. 84p. Thesis.

The determinantal approximation technique for the solution of N/D equations in S-matrix theory is investigated. It is found that this approximation, when suitably "optimized," yields accurate solutions for a wide class of problems. The method is applied to the ρ bootstrap problem in both the conventional "δ-function approximation" and a more reasonable Breit–Wigner model. A surprising result emerges, for whereas the ρ exists as a bootstrapped "particle" with a width of 525 MeV in the δ-function model, it fails to be bootstrapped at all in the Breit–Wigner model. The reason for this effect is discussed. The technique is also applied to a calculation of the P_{11} phase shift in πN scattering, using both elastic and inelastic unitarity in the N/D equations. It is confirmed that elastic unitarity alone is unable to generate the correct P_{11} phase shift, but inclusion of a proper inelasticity factor in a one-channel N/D calculation using a method proposed by Froissart is indeed capable of doing so without the introduction of CDD poles. It is also shown, in an approximate treatment of a two-channel (πN,πN*) model, that the inelasticity factor obtained as the result of interchannel coupling is indeed compatible with the known low energy phase shift analysis results, which when coupled with an assumed flat behavior for the inelasticity at higher energies, is successful in producing the correct P_{11} phase shift. (Disser. Abstr.)

32727 SUM RULES FOR π–N SCATTERING IN THE BACKWARD DIRECTION. Capocaccia, D.; Ciccotti, G. (Univ., Rome). Nuovo Cim., 61A: 369-89(June 1, 1969).

Finite-energy sum rules (FESR) at fixed u are written for the πN scattering amplitudes $A^I{}_u$, $B^I{}_u$, $I_u = \frac{1}{2}, \frac{3}{2}$ (I_u isospin exchanged in the u-channel) and the consistency between the Regge terms, as obtained by high-energy data, and the integrals over the low-energy region are verified. The FESR are then used to obtain a better determination of the Regge parameters for Δ_δ-trajectory exchange. In particular, a negative sign for the residue near u = 0 is found. Finally the results are employed to discuss the validity of the "mean-value principle," developed by Dolen, Horn and Schmid for the Regge boson exchange, in the case of fermion exchange ($u \simeq 0$); it is found that the generalization of this principle does not seem possible for the amplitudes studied, at least if one tries to represent the amplitude of a single channel with the fermion Regge term alone. (auth)

32728 SUPERCONVERGENCE AND $Y_1^*(1385)$ $\Sigma\pi$ COUPLING. Agarwal, B. K.; Seth, V. P. (Allahabad Univ., India). Nuovo Cim., 61A: 390-6(June 1, 1969).

Superconvergent sum rules for the processes $\pi N \rightarrow \pi N$, $(\bar{K}\Sigma \rightarrow \bar{K}\Sigma) + (K\Sigma \rightarrow K\Sigma)$, $\pi\Sigma \rightarrow \pi\Sigma$ and $(\bar{K}N \rightarrow \bar{K}N) + (KN \rightarrow KN)$ are constructed and used for predicting the $Y_1^*(1385)$ $\Sigma\pi$ coupling. (auth)

32729 OFF-MASS SHELL CORRECTIONS TO PION–NUCLEON SCATTERING AMPLITUDES. Katzin, Joel Carl. College Park, Md., Univ. of Maryland, 1968. 48p. Thesis.

Off-mass shell corrections to pion-nucleon scattering amplitudes are calculated using fourth order perturbation theory. A comparison is made to a prescription formulated by Adler. (Disser. Abstr.)

32730 EXACT ABSORPTIVE CORRECTIONS AND THE COMBINED EXCHANGE-CHANNELS MODEL. Lopez-Cepero, Arnold Buist. Durham, N. C., Duke Univ., 1968. 126p. Thesis.

The absorptive peripheral model, proposed by Gottfried and Jackson, Durand and Chiu, is developed in such a form as to give

a simple, direct interpretation of the production reaction $\pi^+p \rightarrow \omega^0N^{*2+}$ for P_{lab} up to 4.0 GeV/c. This development has, primarily, two features: (1) Calculation of the absorptive form factors directly from the rotation coefficients of the first and second kind—$d^j_{m'm}(x)$ and $C^j_{m'm}(z)$, respectively; (2) Consideration of the effect of the t- and u-channel contributions, separately and combined, over the full range of momentum transfer. The direct consequences of this approach are as follows: Form factors more directly associated with the relative helicities of initial and final state; an easy, direct, calculable expression for the total reaction cross section; and inclusion of baryon exchange. For the $\pi^+p \rightarrow \omega^0N^{*2+}$ reaction, over the range of energies considered, the t- and u-channel exchange mechanisms appear to be distinctly limited to, respectively, rho-meson exchange and proton exchange. The overall effect of combining the two exchange channels, in contrast to either exchange channel considered by itself, is a much improved fit to the data, with quite excellent reproduction of the angular distributions and a varying range of agreement for the spin-space density matrix terms of the ω^0 and N^{*2+} resonances. (Disser. Abstr.)

32731 DISPERSION-THEORETICAL CALCULATION OF COULOMB CORRECTIONS TO THE πN-SCATTERING PHASE SHIFTS. Sauter, E. (Kernforschungszentrum, Karlsruhe, Ger.). Nuovo Cim., 61A: 515-24(June 1, 1969).

The S-matrix method of Dashen–Frautschi is used to calculate Coulomb corrections to the πN phase shifts. The agreement with the conventional method of van Hove and Schnitzer in the nonrelativistic region is very good. This is another confirmation of the S-matrix method and opens the way to a relativistic treatment of the problem. (auth)

32732 DO THE LOW-ENERGY K^-p PARAMETERS LEAD TO A CONSISTENT PREDICTION FOR THE ΛKN COUPLING CONSTANT? Martin, A. D. (Univ. of Durham, Eng.); Queen, N. M.; Violini, G. Phys. Lett., 29B: 311-13(May 26, 1969).

A simple consistency test is found to be satisfied by the existing constant scattering length and constant K-matrix parametrizations of the low-energy K^-p data, but not by the K-matrix parametrization of Kim. An argument used by Chan and Meiere to rule out the constant scattering length solution is shown to be invalid. (auth)

32733 APPLICATION OF THE CHIRAL ALGEBRA TO THE PION–NUCLEUS ELASTIC SCATTERING. D'Auria, R. (Univ., Turin); Napolitano, E.; Soliani, G.; Molinari, A. Phys. Lett., 29B: 285-8(May 26, 1969).

Commutation relations of the chiral algebra and PCAC are used to derive sum rules for the pion-nucleus elastic scattering at the threshold. Saturation properties of the sum rules are discussed. (auth)

32734 CONCERNING THE GRAVITATIONAL MOMENT OF THE PROTON. Vasil'ev, B. V. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 9: 175-7(Mar. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 299-301(Mar. 5, 1969).

The possible existence of a proton gravitational moment was previously considered. In the presence of such a moment, the frequency of the proton magnetic resonance depends on the direction of the magnetic field. It was later observed that the mean value of the proton resonance frequencies in fields directed vertically upward and downward differs from the mean resonance frequency in horizontal fields. An attempt was made to verify these observations by measuring the NMR frequencies in vertical and horizontal fields, using the flow-through sample procedure. No such effect was observed in magnetic fields smaller than one Oersted. (L.B.S.)

32735 STABILITY OF THE SOLUTIONS TO THE LOW EQUATIONS vs. PRODUCTION. Lebrun, J.-P. (McGill Univ., Montreal). Nuovo Cim., 61A: 553-66(June 1, 1969).

The scheme developed by the author to solve the three-particle unitarity equations is implemented for the Low equations of the symmetric pseudoscalar field theory. A closed-form solution is obtained for the inelastic P_{11} amplitude in terms of the elastic phase shifts using an approximate crossing matrix. ($N\bar{N}$) production is found to dominate the P_{11} $N\pi\pi$ states, but the inelastic effect on the P_{11} phase shift is found to be almost negligible. This result is compared with other methods of treating the three-particle states. (auth)

32736 ZEROLOGY AND THE s-WAVE SCATTERING LENGTH OF THE SYMMETRIC PION–NUCLEON FORWARD SCATTERING AMPLITUDE. Zovko, N. (Inst. Ruder Boskovic, Zagreb). Nucl. Phys., B11: 231-9(1969).

Zeros of the symmetric πN forward scattering amplitude are considered and the dispersion relation for the inverse amplitude is used for the study of the low-energy scattering parameters. The estimated positions of zeros and the corresponding residues enabled the simplest possible parametrization form of the amplitude to be written, which is very approximately valid for $\omega^2 \lesssim 1$. The s-wave scattering length and the asymptotic limit of the total cross section are predicted to be $a^{(+)} = 0.045$ (natural units) and $\sigma_T(\infty) = 22.3$ mb. (auth)

32737 DERIVATIVE SUM RULES AND INCONSISTENCIES IN THE LOW-ENERGY $\bar{K}N$ SCATTERING PARAMETERS. Queen, N. M.; Leeman, S.; Yeomans, F. E. (Univ. of Birmingham, Eng.). Nucl. Phys., B11: 115-26(1969).

The KNΛ and KNΣ coupling constants predicted by kaon-nucleon forward dispersion relations are particularly sensitive to the parametrization used to extrapolate the $\bar{K}N$ scattering amplitude into the unphysical region. The dispersion relations which have hitherto been considered do not provide a sufficiently stringent and unambiguous consistency test to discriminate between alternative parametrizations which have been proposed. New sum rules are derived from the condition that the coupling constants defined by the dispersion relations should be energy-independent. Although these sum rules utilize the same input data as the conventional dispersion relations, they are entirely independent of the values of the coupling constants and provide a strong consistency requirement. Numerical tests of the sum rules show that all recent parametrizations of the low-energy $\bar{K}N$ scattering amplitude are inconsistent with the remainder of our knowledge of kaon-nucleon interactions. It is suggested that future parametrizations of the experimental data should incorporate more theoretical constraints. (auth)

32738 FORM FACTOR OF Δ(1236) FROM O(4,2) DYNAMICS. Corrigan, D. (Univ. of California, Los Angeles); Hamprecht, B.; Kleinert, H. Nucl. Phys., B11: 1-6(1969).

The form factors of the vertex $(\Delta(1236)p\gamma)$ are predicted from the O(4,2) current which has been successful in reproducing the mass spectrum of the baryon resonances and the electromagnetic structure of the nucleons (in particular the double pole shape of $G^p_M(t)$ and $G^n_M(t)$). The predictions are in excellent agreement with electro-excitation measurements up to momentum transfers of 2.5 $(GeV/c)^2$. (auth)

32739 COMPARISON OF THE REGGE-POLE MODEL AND THE ABSORPTION MODEL FOR THE PRODUCTION OF SPIN-$\frac{3}{2}^+$ PARTICLES IN MESON–NUCLEON COLLISIONS. Griffiths, D. (Johns Hopkins Univ., Baltimore); Jabbur, R. J. Nucl. Phys., B11: 7-20(1969).

High-energy reactions of the type $0^- + \frac{1}{2}^+ \rightarrow 0^- + \frac{3}{2}^+$ are studied. The problem is approached theoretically in two different ways: the absorptive peripheral model and the Regge-pole theory. The latter is treated with particular emphasis on the removal of kinematic singularities from the helicity amplitudes. The models are finally compared with one another and with recent experimental data on the production of the N*(1236) and Y*(1385) resonances. (auth)

32740 CONSISTENCY TESTS OF THE LOW-ENERGY K^-p PARAMETRIZATIONS. Martin, A. D. (Univ. of Durham, Eng.); Queen, N. M.; Violini, G. Nucl. Phys., B10: 481-95(1969).

The value of the ΛKN coupling constant g^2_Λ predicted by forward KN dispersion relations is particularly sensitive to the model used to continue the $\bar{K}N$ amplitude into the unphysical region. The various parametrizations which have been used to analyze the low-energy K^-p scattering data are reviewed and compared, and a simple consistency test of these parametrizations is proposed. The consistency condition is satisfied by the existing constant scattering length parameters and by a new constant K-matrix solution obtained by Martin and Sakitt, but not by the effective-range K-matrix parametrization of Kim. Other recently proposed consistency tests are discussed, and it is shown in particular that an agrument used by Chan and Meiere to rule out the determination of g^2_Λ using constant scattering lengths is not valid, since the inconsistency found by them in this case is due entirely to the incorrect behavior of the extrapolated amplitude at the Σπ threshold. It is concluded that, of the existing low-energy K^-p parametrizations, only the constant scattering length and constant K-matrix solutions are consistent. Using either solution, the forward dispersion relations predict $g^2_\Lambda \approx 4$, a value considerably smaller than that suggested by SU(3) invariance. (auth)

32741 RESONANCES AND REGGE POLES IN PION–NUCLEON SCATTERING. Donnachie, A. (Glasgow Univ.); Kirsopp, R. G. Nucl. Phys., B10: 433-52(1969).

The generalized interference model is shown to give a remarkably good description of pion-nucleon scattering in the resonance region. (auth)

32742 PARTIAL-WAVE ANALYSIS OF $\pi^- + p \rightarrow \eta + n$. Botke, John C. (Univ. of California, Santa Barbara). Phys. Rev., 180: 1417-22(Apr. 25, 1969).

It is shown that by using the nucleon pole and a sum of direct-channel resonances, a reasonable fit to both the differential and total cross sections, for the process $\pi^- + p \rightarrow \eta + n$, is obtained for incident-pion laboratory kinetic energies (T_π) between threshold and 1.3 GeV. Inelastic branching ratios for the ηn channel are predicted with results consistent with experiment. The η-nucleon coupling constant is found to be $g_{\eta NN}^2/4\pi \lesssim 10^{-4}$. By assuming the spin and parity of the N(2650) to be $J^P = 11/2^-$, agreement with the polarization data near the N(2650) is obtained. However, this model can not give a good fit to the differential cross section data at $T_\pi = 2.41$ and 2.93 GeV. (auth)

32743 u-CHANNEL REGGE POLES AND TOTAL CROSS SECTIONS. Phillips, Roger J. N.; Ringland, Gordon A. (Rutherford Lab., Chilton, Eng.). Phys. Rev., 180: 1603(Apr. 25, 1969).

It has been suggested that u-channel exchanges may explain the structure versus energy of total cross sections and forward amplitudes at fixed t, and an application to πN scattering has been made. It is remarked that this idea cannot be generally valid, since it does not work in many reactions, such as K^+p scattering. Hence, the πN application seems implausible. (auth)

32744 ELECTROMAGNETIC DECAYS OF BARYON RESONANCES IN THE HARMONIC-OSCILLATOR MODEL. Faiman, David; Hendry, Archibald W. (Univ. of Illinois, Urbana). Phys. Rev., 180: 1572-7(Apr. 25, 1969).

The harmonic-oscillator model for baryons is used to estimate the radiative widths of the observed N* resonances. In the "second resonance region" of pion photoproduction, both the $S_{11}(1550)$ and $D_{13}(1525)$ resonances [and possibly the $P_{11}(1470)$, depending on what should be taken as its $N\pi$ width] are expected to be important, while in the "third resonance region" $F_{15}(1690)$, $S_{11}(1710)$, and $D_{13}(1690)$ are expected to have comparable contributions. The mixing angle between the two S_{11} resonances is determined to be about 35°. In inelastic electron scattering $ep \rightarrow eN^*$, the $S_{11}(1550)$ and $D_{13}(1525)$ resonances are expected to dominate over the $P_{11}(1470)$. The neutral $P_{11}(1470)$ radiative width is found to be smaller than the charged width, in contrast to an SU(3) $\overline{10}$ assignment for this resonance. (auth)

32745 BARYON MASS SPECTRUM IN A STRONG-COUPLING MODEL WITH O(3) ⊗ SU(2) ⊗ SU(3) SYMMETRY. Dullemond, C. (Univ. of Nijmegen, Netherland). Phys. Rev., 180: 1468-73 (Apr. 25, 1969).

A model is presented in which an octet of pseudoscalar mesons interacts strongly with an octet of static spin-$\frac{1}{2}$ baryons. In addition to this, the baryons carry a central potential in which a hypothetical spinless meson χ is bound. The resulting Hamiltonian is symmetric under O(3) ⊗ SU(2) ⊗ SU(3) transformations. The lowest positive-parity multiplets then turn out to be $\{8\}^{\frac{1}{2}+}$ and $\{10\}^{\frac{3}{2}+}$; the lowest negative-parity multiplets are $\{1\}^{\frac{1}{2}-}$ and $\{1\}^{\frac{3}{2}-}$, followed by $\{8\}^{\frac{1}{2}-}$ and $\{8\}^{\frac{3}{2}-}$. A short discussion of symmetry breaking is given. (auth)

32746 PION SCATTERING LENGTHS. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 180: 1449-53 (Apr. 25, 1969).

New, approximate expressions for πX scattering lengths are derived, where X is a hadron other than a pion. The expressions are obtained from simple dispersion relations involving amplitudes that are well approximated by low-energy poles. Results are calculated for πN, $\pi\Sigma$, $\pi\Lambda$, $\pi\Xi$, and πK scattering; the πN results are in excellent agreement with experiment. The most important term in the expression for crossing-odd amplitudes is a ρ-exchange term. This term gives results similar to the current-algebra results, but the parameters are those of the ρ Regge trajectory at $t = 0$. It is shown that the very small value of the crossing-even πN scattering length implies that the partial conservation of axial-vector current condition applies to the N*(1236)-N matrix element, as well as the N-N element. The relevance of Dolen-Horn-Schmid duality, and the Harari conjecture concerning the Pomeranchuk trajectory, are discussed. (auth)

32747 POSSIBLE ZERO AT A WRONG-SIGNATURE SENSE POINT ON THE Δ TRAJECTORY. Henyey, F.; Kane, G. L. (Univ. of Michigan, Ann Arbor). Phys. Rev., 180: 1607-8(Apr. 25, 1969).

Comments are made on the proposed vanishing of the Δ Regge trajectory residue at $\alpha\Delta = \frac{1}{2}$, giving experimental tests of this hypothesis and an interpretation of such a result. (auth)

32748 HARMONIC-OSCILLATOR MODEL FOR BARYONS. Faiman, David; Hendry, Archibald W. (Univ. of Illinois, Urbana). Phys. Rev., 180: 1609-10(Apr. 25, 1969).

A detailed analysis is presented of all positive-parity resonances predicted by the harmonic-oscillator model to lie in the 1500 to 2000-MeV mass region, particular attention being focused on their likelihood of experimental discovery. Some further comments on the model are also added. (auth)

32749 KINEMATIC REFLECTIONS IN MULTIPLE-PRODUCTION PROCESSES. Rushbrooke, J. G. (Cavendish Lab., Cambridge, Eng.). Phys. Rev., 180: 1611-3(Apr. 25, 1969).

The functional dependence of one subenergy variable of a multiperipheral chain upon another is shown to be extremely strong at fixed, small values of all momentum transfers. A general class of kinematic reflections is therefore likely to occur when Regge asymptotic terms appear in an amplitude. The special case of three final-state particles (the Deck effect) is discussed in relation to a recent conjecture of Chew and Pignotti. (auth)

32750 COMPARISON OF PHASE-SHIFT ANALYSIS SOLUTIONS TO π^-p SCATTERING DATA. Brody, A. D. (Stanford Linear Accelerator Center, Calif.); Leith, D. W. G. S.; Levi, B. G.; Shen, B. C.; Herndon, D.; Longacre, R.; Price, L.; Rosenfeld, A. H.; Soeding, P. Phys. Rev. Lett., 22: 1401-5(June 23, 1969).

A comparison between the π^-p scattering data and the predictions of the various phase-shift analyses is presented. In particular, it is pointed out that the dispersion relation fit of the CERN group fails to represent the data. (auth)

32751 CALCULATION OF THE PARAMETERS OF LOW-ENERGY πN SCATTERING. Radutskii, G. M.; Tabachenko, A. N. JETP Lett. (USSR) (Engl. Transl.), 9: 82-5(Jan. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 142-5(Jan. 20, 1969).

The "hard pion" technique is used in a method based on current algebra, PCAC, and CVC to calculate the isotope-antisymmetrical lengths of πN scattering. (L.B.S.)

32752 NEW FEATURES IN THE HIGH-ENERGY πN DIP STRUCTURE. Odorico, R. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim., Lett., 1: 725-7(May 11, 1969).

It is found that if high-energy π^+p polarizations change sign near $t \approx -2.1$, as is strongly suggested by the phase shifts, the phenomenological P′ and ρ Regge poles, proposed previously to describe high-energy πp scattering in this region of t, could no longer be regarded as factorizable objects. Although one could interpret the $A'^{\pm}$ zeros near $t \approx -2.1$ as dynamical zeros unrelated to the crossing of the value $\alpha = -1$ by P′ and ρ trajectories, in this case the main justification of the Regge pole model, that is, the association of the πp dip structure with the crossing of integer values by P′ and ρ trajectories, would fail. (J.F.P.)

32753 TESTS OF THE REGGE-POLE MODEL WITH ABSORPTION IN $\pi N \rightarrow \omega N(\Delta)$. Le Bellac, M.; Plaut, G. (Physique Theorique, Nice). Nuovo Cim., Lett., 1: 721-4(May 11, 1969).

The proposed tests of the Regge pole model with absorption in the reactions $\pi + N \rightarrow \omega + N(\Delta)$ are based on two assumptions. These assumptions are that ρ exchange becomes dominant at high energies (in particular dominating B exchange) and that the absorption corrections are diagonal in the helicities, i.e., helicity-flip amplitudes are negligible in elastic scattering. Otherwise the tests are independent of the way in which absorption is introduced and insensitive to previously proposed modifications. Also the tests do not depend on the unknown $\omega + N$ or $\omega + \Delta$ elastic scattering. From comparison with experiment it is concluded that these tests do not give any clear evidence in favor of the absorbed Regge pole model in the reactions studied. (J.F.P.)

32754 FIREBALL PRODUCTION FROM THE STANDPOINT OF QUANTUM FIELD THEORY. Akimov, V. N.; Roizen, I. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 1067-76 (May 1969). (In Russian).

Using a method previously developed, the processes involving one fireball production in pp interactions are considered. Main parameters of these processes are obtained. It is shown that they are important in the energy region $E_L \sim 30$ to 250 GeV. (auth)

32755 SOME RELATIONS FOR LOW-ENERGY PARAMETERS OF πN SCATTERING. Vainshtein, A. I.; Zakharov, V. I. Yadern. Fiz., 9: 1060-6(May 1969). (In Russian).

Some relations for low-energy parameters of πN scattering are obtained basing on the assumption that the pion mass is small as compared to the characteristic mass of strong interactions. The relations obtained are in agreement with the experimental data. (auth)

32756 EFFECTIVE MASS SPECTRUM OF MULTIPION SYSTEM IN INELASTIC INTERACTION AT HIGH ENERGIES. Azimov, S. A.; Beter, E. V.; Gulyamov, U. G.; Levin, A. Ya.

(Inst. of Nuclear Physics, Tashkent). Yadern. Fiz., 9: 1040-5 (May 1969). (In Russian).

On the basis of the diffraction model spectra of the invariant effective mass W_π of the system of all the secondary pions in the reaction $\pi + p \rightarrow n\pi + p$ at high energies (n = 3,5,7) are obtained using the Monte Carlo method. The method proposed can be used for any multiplicities. The W_π spectra can simulate under definite conditions multipion resonances with the large mass. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 32619 and 32682.

32757 (ITF-69-30) FESR FOR THE SCATTERING AMPLITUDE SATISFYING QUASIPOTENTIAL EQUATION. Enkovskii, L. L.; Lendel, A. I.; Tutik, R. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki), 1969. 6p. (In Russian). (CONF-690417-1). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Finite-energy sum rules are considered using the small-angle scattering amplitude derived previously from a quasipotential equation of Logunov and Tavkhelidze for the scattering amplitude in quantum field theory. Elastic N + N and N + $\bar{N}$ are considered. (J.F.P.)

32758 HYPERON-NUCLEON INTERACTIONS. Brown, James Thompson Jr. Boulder, Colo., Univ. of Colorado, 1968. 80p.

Thesis.

A theoretical potential describing the hyperon-nucleon interaction is derived, based on a one-boson-exchange model. Unitary symmetry is used to relate the couplings of the pseudoscalar and vector meson octets and the scalar and vector unitary singlets. The coupling of the ΛN and ΣN particle channels was taken into account. The K matrix for the scattering is determined by numerically integrating the Schroedinger equation. The T = 1/2 effective ranges, scattering lengths, and cross sections for the ΛN and ΣN interactions are found from the K matrix. The model is relatively insensitive to small changes in the parameters. Within a certain range of values for the coupling constants of the unitary singlets, it may be possible to have a continuum of solutions. A very good fit to the experimental data is obtained with the model. It is also found that the ΣN channel is quite important for an accurate description of the ΛN scattering at energies well below the ΣN threshold. (Disser. Abstr.)

32759 SEPARABLE POTENTIAL FITS TO NUCLEON-NUCLEON SCATTERING DATA. Mougan, Thomas Robert. Berkeley, Calif., Univ. of California, 1968. 80p.

Thesis.

The Arndt-MacGregor (Livermore) nucleon-nucleon phase shifts and mixing parameters for partial waves through J = 4 are fitted in the energy range 0 to 400 MeV by separable potentials. It is demanded that the partial-wave scattering amplitudes resulting from the potentials have singularities only for real negative values of the complex energy variable, in addition to the usual right-hand unitarity cut guaranteed by the Lippman-Schwinger formalism. It is also demanded that the appropriate partial-wave amplitudes contain the deuteron pole and the singlet antibound state pole at the correct energies. The use of these fits in probing the off-energy-shell behavior of scattering amplitudes is discussed. (Disser. Abstr.)

32760 MODIFIED HERNDON AND TANG Λ-N POTENTIALS. Schrils, R.; Darley, H. M. (Univ. of Kentucky, Lexington). Phys. Lett., 29B: 291-2(May 26, 1969).

Attractive as well as repulsive tensor interactions are added to potentials obtained by Herndon and Tang, in such a way that reasonable agreement is obtained between the Λ-proton scattering data and the binding energies of $^3_\Lambda$He and $^4_\Lambda$He. (auth)

32761 HYPERNUCLEI. Danysz, Marian; Pniewski, Jerzy. pp 63-70 of Maria Sklodowska-Curie: Centenary Lectures, Vienna, International Atomic Energy Agency, 1968.

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

A survey is given on hypernuclei research. The composition of hypernuclei, the Λ-N interaction, hypernuclei decay and double hypernuclei are discussed. (J.F.P.)

32762 THEORETICAL CALCULATION OF THE CROSS SECTION FOR PAIR PRODUCTION IN A PROTON-PROTON COLLISION. Parker, Barry R. Logan, Utah, Utah State Univ., 1968. 108p.

Thesis.

The differential cross section for pair production in a proton-proton collision was calculated. Standard perturbation methods with retarded interactions were used throughout the calculation. A total of twelve Feynman diagrams contributed to the process. The results were presented in the form of two graphs. In the first, differential cross section was plotted versus energy of incoming particle. This graph indicated that the cross section near threshold was fairly high but decreased rapidly with increasing energy, leveling off at about 10^{-32} cm^2/MeV^2-sterads at 100 MeV. In the second graph differential cross section was plotted against angle between pair. This graph indicated that the cross section increases with decreasing angle between the pairs. (Disser. Abstr.)

32763 ABSORPTION OF LOW-ENERGY π^+ AND BOUND K MESONS BY DEUTERONS. Reitan, A. (Norges Tekniske Hoegskole, Trondheim, Norway). Nucl. Phys., B11: 170-6(1969).

The reactions $\pi^+ + d \rightarrow p + p$ and $K^- + d \rightarrow \Lambda + n$, $\Sigma^0 + n$ and $\Sigma^- + p$ are studied for low-energy pions and bound kaons in a phenomenological model. The mesons are assumed to be absorbed either directly by one nucleon, or by one-meson-exchange processes. (auth)

32764 ANALYSIS OF SMALL-ANGLE PROTON-^{4}He ELASTIC SCATTERING AT 1 GeV. Cromer, A. H. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., B11: 152-8 (1969).

Glauber's plural scattering formalism is used to study the sensitivity of the p-^{4}He elastic scattering at 1 GeV to the granularity of the nucleus. It is found that only the data with $-t > 0.2$ (GeV/c)^2 is sensitive to the A of the nucleus but that the Glauber formalism is not reliable enough in this region to draw any more quantitative conclusions. (auth)

32765 ELASTIC PION-DEUTERON SCATTERING AT HIGH ENERGIES. Michael, C. (Rutherford Lab., Chilton, Eng. Univ. of Wisconsin, Madison); Wilkin, C. Nucl. Phys., B11: 99-114 (1969).

Elastic pion-deuteron scattering at 3.65 and 3.75 (GeV/c) is analyzed on the basis of Glauber theory, particular attention being paid to the deuteron D-state and to the spin dependence and phase variation of the pion-nucleon amplitudes. The good overall agreement between theory and experiment would be further improved with a larger value of the deuteron quadrupole form factor than that given by a Hamada-Johnston type wave function. (auth)

32766 REGGE POLES AND LARGE-ANGLE SCATTERING. Dean, N. W. (Vanderbilt Univ., Nashville). Nucl. Phys., B10: 496-500(1969).

The limiting form of a Regge amplitude for large values of both s and |t| is studied. If such a term dominates the amplitude, a limit on the behavior of the trajectory as $t \rightarrow -\infty$ is obtained. Results obtained by fitting simply parametrized Regge terms to the pp scattering data near 90° are presented. (auth)

32767 FROM SOFT TO REAL PIONS IN NUCLEI AND EXTENDED SYSTEMS. Ericson, M. (Massachusetts Inst. of Tech., Cambridge); Figureau, A.; Molinari, A. Contract AT(30-1)-2098. Nucl. Phys., B10: 501-15(1969).

The finite-mass correction to the soft-pion limit is discussed using the example of the pion-nucleus charge-exchange amplitude. It is shown that the main deviation from the soft-pion limit is the distortion of the pion wave by the nucleus, which ensures unitarity. If the pion-nucleus interaction can be represented by an equivalent optical potential, the soft-pion limit is the Born approximation. The composite structure of the nucleus is responsible for smaller deviations. Experiments support this picture. (auth)

32768 INTERACTIONS OF HADRONS WITH NUCLEI AT HIGH ENERGY. I. Trefil, J. S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 180: 1366-78(Apr. 25, 1969).

It is shown that under certain assumptions the Glauber multiple-scattering series can be summed explicitly to give a closed expression for the amplitude describing the interaction of a high-energy particle with a nucleus. The advantages of this description are discussed, and it is shown that available data are well described by the theory. Application of the theory to inelastic processes is given, and it is shown how quantities like σ_{A_1N} and $\sigma_{\Sigma N}$, total scattering cross sections which are not otherwise measurable, can be obtained. (auth)

32769 PROTON-PROTON ELASTIC SCATTERING AT HIGH ENERGIES AND LARGE ANGLES, AND THE INCOHERENT DROPLET MODEL. Wilcox, Roland E.; Huang, Justin C. (Univ. of Missouri, Columbia). Phys. Rev., 180: 1405-9(Apr. 25, 1969).

A study was made of the elastic proton-proton scattering at high energies and large angles, using a model first proposed by K. Huang. This model decomposes a proton during collision into N subunits and recombines them after collision in an incoherent combinatorial manner. The technique used is more general than the asymptotic methods used by Huang in obtaining the probabilities for the final states. The new procedure allows the range of validity for the model to be extended, since asymptotic expansions are no longer used. The analysis is limited to spinless protons, and to regions of high energy where there exists no discontinuity in the shape of the angular distribution such as was found by Allaby et al., around P_L = 8 to 11 BeV/c. The theoretical curves are in good agreement with the experimental results from $\theta_{c.m.}$ = 65 to 90° and P_L = 14 to 27 BeV/c, while the asymptotic expressions are in good agreement only from around 76° to 90°. The experimentally observed quenching of large-momentum-transfer states as the energy increases is reproduced. (auth)

32770 METHODS OF TREATING COULOMB INTERFERENCE CORRECTIONS IN POTENTIAL SCATTERING. Rae, Stephen; Thurnauer, Peter (Univ. of Vermont, Burlington). Phys. Rev., 180: 1387-92(Apr. 25, 1969).

Three distinct, though related, formalisms, developed by Block, by West, and by Auvil, for dealing with Coulomb interference corrections to nuclear potential scattering problems are considered. Such formalisms are particularly relevant to the analysis of recent pion-helium scattering experiments, and their equivalence is examined. It is shown that to first order in the Coulomb coupling parameter n, the results for the scattering amplitudes given by West and by Auvil (as generalized in the present work) are equivalent but differ from those suggested by Block. On the other hand, to first order in n the results for the cross sections are all seen to be equal. (auth)

32771 HIGH-ENERGY BACKWARD ELASTIC PROTON–DEUTERON SCATTERING AND BARYON RESONANCES. Kerman, A. K.; Kisslinger, L. S. (Massachusetts Inst. of Tech., Cambridge. Case Western Reserve Univ., Cleveland). Contract AT(30-1)-2098. Phys. Rev., 180: 1483-9(Apr. 25, 1969).

Elastic proton-deuteron scattering at 1 GeV shows a peak at 180° which seems larger than that predicted by a simple nucleon-transfer mechanism. A straightforward generalization of the nucleon-transfer mechanism is obtained through a Regge extension of the model, permitting a calculation of the (p,d) process using the parameters of a (π^+,p) Regge model. A dynamic interpretation is attempted via a static field theory. It is estimated that a deuteron contains the N*(1688) resonance with a $\frac{1}{2}$ – 1% probability and that this accounts for about half of the backward proton-deuteron scattering at 1 GeV. (auth)

32772 OFF-ENERGY-SHELL BEHAVIOR OF PARTIAL-WAVE SCATTERING AMPLITUDES. Mongan, Thomas R. (Univ. of California, Berkeley). Phys. Rev., 180: 1514-21(Apr. 25, 1969).

The off-energy-shell behavior of several potential models for the nucleon-nucleon interaction is compared. This is done by comparing the Kowalski–Noyes half-off-shell functions $f_l(p,k)$ resulting from the different models. (auth)

32773 BROKEN-DUALITY MODEL FOR THE REACTION $pp \rightarrow \pi^+d$. Barger, V.; Michael, C. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 22: 1330-4(June 16, 1969).

A model based on a broken (N_α,N_γ) exchange degeneracy is proposed to explain the structureless data for the $pp \rightarrow \pi^+d$ differential cross section. An effective Regge trajectory is determined which agrees with our prediction. Quantitative fits to the data are presented and physical aspects of the broken degeneracy are discussed. (auth)

32774 THREE-PARTICLE SCATTERING IN QUANTUM MECHANICS. Proceedings of the Texas A and M Conference Held at College Station, Texas, April 4–6, 1968. Gillespie, J.; Nuttall, J. (eds.). New York, W. A. Benjamin, Inc., 1968. 461p. (CONF-680429).

The conference included eight invited papers, two of which were abstracted previously in NSA. For abstracts of these papers see abstract numbers 22: 87527 and 22: 37162. Separate abstracts were prepared for six papers. Contributed papers appeared in the proceedings in abstract form only. (J.F.P.)

For abstracts of individual papers see: 32775, 32776, and 32854–32857.

32775 VARIATIONAL CALCULATIONS ON THE NUCLEAR THREE-BODY PROBLEM WITH REALISTIC LOCAL POTENTIALS. Delves, L. M. (Univ. of Sussex, Brighton, Eng.). pp 369-416 of Three-Particle Scattering in Quantum Mechanics. Gillespie, J.; Nuttall, J. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Conference on Three-Particle Scattering in Quantum Mechanics, College Station, Tex. See CONF-680429.

Calculations on the bound and zero energy scattering states of the three-nucleon system using local potentials fitted to the two-nucleon scattering data are discussed. The reason for performing these calculations, the reason for the method used, and the results are considered. (J.F.P.)

32776 CALCULATION OF THREE-NUCLEON COLLISIONS. Amado, R. D. (Univ. of Pennsylvania, Philadelphia). pp 325-67 of Three-Particle Scattering in Quantum Mechanics. Gillespie, J.; Nuttall, J. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Conference on Three-Particle Scattering in Quantum Mechanics, College Station, Tex. See CONF-680429.

The results of some numerical calculations in the three-body problem applied to the neutron–deuteron system are reviewed. Emphasis is given to the reasons and methods for performing these calculations. (J.F.P.)

Particle Invariance Principles and Symmetries

General

32777 (STI/PUB-179) MARIA SKLODOWSKA-CURIE: CENTENARY LECTURES. Proceedings Series. Proceedings of a Symposium held in Warsaw, 17–20 October 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 205p. (In Several Languages). (CONF-671055). IAEA: $5.00; Austrian Schillings 130,–; £2.1.8; F Fr 24,50; DM 20,–.

Separate abstracts are prepared for 10 of the 14 papers. (C.E.S.)

For abstracts of individual papers see: 31618, 32144, 32761, 32778, 32867, 32959–32961, and 33139.

32778 CONSERVATION PRINCIPLES, SYMMETRIES, AND INVARIANCE LAWS. Van Hove, Leon. pp 33-44 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968.

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

Some aspects of the wide role played by symmetry considerations in modern physics are discussed. Symmetry in physics, exact symmetries and conservation principles, and approximate symmetries are covered. (J.F.P.)

32779 A CONSERVED W-SPIN ALGEBRA FOR COLLINEAR PROCESSES INVOLVING TIME-, SPACE-, LIGHT-LIKE OR NULL OBJECTS. Wolf, Kurt Bernardo (Tel-Aviv Univ., Israel). Nucl. Phys., B11: 159-69(1969).

A W-spin algebra is defined on the (Bargmann–Wigner) internal carrier space of the spin group of any kind of object: time-, space-, light-like or null. This W-spin algebra is the same in all four cases and is conserved in collinear processes. For time-like systems, the usual W-spin formalism is regained. Space-like objects of definite W-spin are shown to be (finite-dimensional) non-unitary irreducible representations of their O(2,1) spin group, formally resembling the O(3) spin of a time-like object of the same W-spin and quark composition. Light-like objects of definite W-spin are shown to be collections of "photon-like" representations of their E(2) spin group. Null systems allow a larger O(3,1) W-spin algebra. (auth)

32780 TWO-VARIABLE EXPANSIONS OF RELATIVISTIC AMPLITUDES AND THE SUBGROUPS OF THE SU(2,1) GROUP. Montgomery, W. (Dublin Inst. for Advanced Studies); O'Raifeartaigh, L.; Winternitz, P. Nucl. Phys., B11: 39-54(1969).

A complete classification of the continuous subgroups of the SU(2,1) group is made in order to consider the possibility of writing two-variable expansions of relativistic amplitudes, incorporating the little group formalism and being explicitly crossing symmetric. It is shown that SU(2,1) has no E_2 subgroup and this severely limits the applicability of such expansions for the scattering of particles with non-equal masses. (auth)

32781 SOLUBLE MODEL FOR BROKEN SYMMETRY EFFECTS. Breitenlohner, P. (Univ. of Graz). Acta Phys. Austr., 28: 59-64(1968).

A generalization of the Zachariasen model is considered in order to study the effects of mass splittings on quantities such as renormalized coupling constants, branching ratios and masses of bound states or resonances. The general formalism of the model is derived. (J.F.P.)

32782 NEW EXTENSION OF THE RANGE OF VALIDITY OF LORENTZ INVARIANCE. Phillips, Peter R. (Washington Univ., St. Louis). Phys. Rev., 180: 1331-2(Apr. 25, 1969).

Lorentz invariance can be violated by interaction terms of the form $Gs_\mu\lambda^\mu$, where s_μ is the spin vector of a particle and λ^μ is a given fixed vector. In the rest frame of the particle, such a term results in an anomalous torque on the spin. Limits are set on its magnitude for electrons and muons by examining its effect on the g-2 experiments. A precision NMR experiment using ^{13}C was carried out to set a limit for the neutron. No violations of Lorentz invariance were found. (auth)

32783 NONINVARIANCE GROUP FOR THE DIRAC COULOMB PROBLEM. Kiefer, H. M.; Fradkin, D. M. (Wayne State Univ., Detroit). Phys. Rev., 180: 1282-8(Apr. 25, 1969).

All bound-state solutions of the Dirac Coulomb problem are shown to provide a Hilbert-space for irreducible representations of the de Sitter group O(4,1). Selected solutions of this problem provide the basis for other representations of O(4,1). These results are compared to analogous results previously obtained for the Schroedinger Coulomb problem. Operator forms of the generators of O(4,1) are explicitly constructed as functions of p and r which operate on the Hilbert space provided by the Dirac problem. (auth)

32784 EXACT CONSEQUENCES OF BROKEN O(4) SYMMETRY FOR REGGE TRAJECTORIES. I. M = 0. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 180: 1423-9(Apr. 25, 1969).

The complete set of constraints imposed by broken O(4) symmetry on Regge daughter sequences having M = 0 are obtained. The constraints determine the pth derivative of all the daughters in terms of a finite number of constants. Similar results are obtained for daughter residues. (auth)

32785 ON V SYMMETRY IN SU(3). Krori, K. D. (Cotton Coll., Gauhati, India). Indian J. Phys., 42: 496-505(Aug. 1968).

Some properties of V-symmetry in SU(3) are discussed. (auth)

32786 POINCARE PARTIALLY INTEGRABLE LOCAL REPRESENTATIONS AND MASS-SPECTRUM. Flato, Moshe; Sternheimer, Daniel (College de France, Paris). Commun. Math. Phys., 12: 296-303(May 6, 1969).

An example is given of an irreducible representation of a finite dimensional Lie algebra containing the Poincaré Lie algebra and giving rise to isolated positive masses. In addition the representation is Poincaré partially integrable (which assures the continuous physical spectrum for the energy-momentum vector) and "Poincaré-covariant" in a weak sense. A connection between this example and some recent impossibility theorems is shown. (auth)

32787 NON-INVARIANCE GROUPS OF DYNAMICAL PROBLEMS. Novaro, O. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 18: 65-73(1969).

There has been recently a great deal of interest in noninvariance groups of dynamical systems mainly with the purpose of generalizing the ideas to the field of elementary particles. The direct construction of noninvariance groups is discussed, using the dynamical variables of several physical systems like the rigid rotator and the harmonic oscillator. The general technique consists in building up operators that depend only on the dynamical variables of the problem and that satisfy some group's Lie algebra. Such a group must have the following characteristics: it must contain as a subgroup, the symmetry group of the system and its Casimir operators be such that all the Hamiltonian's eigenfunctions belong to a single representation of the larger group. This will allow all possible states of the system to be constructed by the mere knowledge of the maximum weight states by the use of a general technique. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 32654, 32660, and 32686.

32788 SU_3 OR $SU_2 \otimes SU_2$: K_{l3} FORM FACTORS AS A SYMMETRY PROBE. Gaillard, M. K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 61A: 499-514(June 1, 1969).

K_{l3} form factors are studied assuming $SU_3 \otimes SU_3$ current commutation relations and pion-pole dominance of the axial-current divergence for small momentum transfer. A correction to the Callan–Treiman relation is derived which is small in the limit of near $SU_2 \otimes SU_2$ invariance and large and negative in the limit of near SU_3 invariance. In the latter limit, the corrected result conforms to the requirements of small "leakage" for SU_3 generators and predicts a negative value for the parameter ξ. (auth)

32789 ELECTRON–POSITRON COLLISIONS AND THE C-INVARIANCE QUESTION. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Phys. Lett., 29B: 308-10(May 26, 1969).

The implications of charge conjugation invariance are reviewed for hadronic processes induced by e^+-e^- collisions. Attention is called to certain features which follow from one photon exchange and which afford the possibility of refining C-invariance tests in a statistically economical way. (auth)

32790 PRESENT STATUS OF EXPERIMENTAL RESULTS RELATING TO CP VIOLATION. Steinberger, J. (Columbia Univ., New York). Comments Nucl. Particle Phys., 3: 73-4 (May-June 1969).

The review of the status of experimental results on CP violation covers CP violation results in three reactions in which the effects are of the order of $2(10)^{-3}$, the superweak model for the structure of CP-violating interactions, and milliweak models. Also considered is the suggestion that C violation in the electromagnetic interaction is responsible. (J.F.P.)

32791 MODEL FOR CP VIOLATION IN THE WEAK INTERACTIONS. Patsakos, George (Stanford Univ., California). Phys. Rev., 180: 1532-7(Apr. 25, 1969).

By requiring that all of the "good" currents of the quark model (vector, axial-vector, tensor, and dual tensor) appear in the phenomenological weak Hamiltonian, a current-current weak Hamiltonian is obtained which contains, in addition to the usual vector terms, a small admixture of the divergences of tensor currents, and which violates CP and T invariance. Some consequences of the model for leptonic and semileptonic weak processes are discussed. Since only the "good" currents appear, the strong-interaction renormalization effects can be dealt with and independent of the absolute strength of the CP-odd coupling, the relative magnitudes of the T-odd effects in various processes can be presented. (auth)

32792 ANGULAR CORRELATION TEST OF TIME-REVERSAL INVARIANCE. Kuebbing, Richard A.; Casper, Karl J. (Case Western Reserve Univ., Cleveland). Nucl. Phys., A130: 672-6(1969).

A test of time-reversal invariance in electromagnetic transitions is proposed in which all possible two-gamma angular correlations in a triple cascade are measured. The results can be combined to yield a term proportional to cos η. (auth)

32793 μ:e RATIO IN $\eta^0 \to \pi^0 l^+ l^-$ AND $X^0 \to \eta^0 l^+ l^-$ AS A TEST OF ELECTROMAGNETIC C NONINVARIANCE. Sehgal, L. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 22: 1269-70(June 9, 1969).

If the decays $\eta^0 \to \pi^0 l^+ l^-$ occur via a C-nonconserving (isovector) electromagnetic interaction, the ratio $\Gamma(\eta^0 \to \pi^0 e^+ e^-)/\Gamma(\eta^0 \to \pi^0 \mu^+ \mu^-)$ should be 3.3. Similarly, if the decays $X^0 \to \eta^0 l^+ l^-$ are induced by a C-nonconserving (isoscalar) interaction, the ratio $\Gamma(X^0 \to \eta^0 e^+ e^-)/\Gamma(X^0 \to \eta^0 \mu^+ \mu^-)$ should be 2.9. (auth)

32794 MULTIPOLE THEORY OF HADRONS. Rumer, Yu. B.; Fet, A. I. (Novosibirsk State Univ., USSR). Yadern. Fiz., 9: 1077-85(May 1969). (In Russian).

A new method is presented to derive the mass formula in the SU(6) theory (Bég–Singh), based on the direct analogy with the dynamical description of the fine structure of atomic terms. The SU(6) group is considered as a symmetry group of the hadronic G-spin (that is conventional spin combined with the unitary spin), and its subgroup SU(3) is interpreted as the symmetry group of the hadron as a whole. (auth)

Applications (Strong)

Refer also to abstracts 32615 and 32724.

32795 FINITE TRANSFORMATIONS OF SU3. Holland, Douglas Francis. Tucson, Ariz., Univ. of Arizona, 1968. 67p. Thesis.

The properties of SU3 finite transformations are investigated. These transformations on the defining three-dimensional complex space are parametrized in a form employing three factors, two of which are the Euler parametrization of an SU2 subgroup. The irreducible representations of the factored parameterization are found explicitly. The formula for the volume element is derived, and the volume element is calculated for all parametrizations discussed. The orthogonality relation is verified for the factored parameterization. Symmetries of the transformation matrices are discussed. A definition of triality results and a proof that it is additive modulus three follows. A generalization of G-parity is presented which reduces correctly for pions. Spherical harmonic basis states are derived as a specialization of the trans-

formation matrix. Differential equations representing the infinitesimal generators are used to derive the infinitesimal generators of Biedenharn. These states are found to have symmetries that suggest their applicability as meson states. One parameter mass formulas for mesons and for baryons are derived. These results support the suggestion that the group parameters have some physical reality in the space of the eight-dimensional representation. (Diss. Abstr.)

32796 FORM FACTORS FOR HADRONIC DECAYS IN BROKEN $SU_6 \times O_3$. Mitra, A. N. (Rutherford Lab., Chilton, Eng. International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 61A: 344-52(June 1, 1969).

A phenomenological model of relativistic meson and baryon interactions with pseudoscalar mesons is proposed on the basis of broken $SU_6 \times O_3$ through a specific ansatz for the dependence of the form factors on the various masses. The decay widths of $L^P = 0^+$, 1^- and 2^+ states for baryons and L = 0, 1 states for mesons reveal very good agreement with experiment. (auth)

32797 PROPERTIES OF 35-PLET OF ONE-BARYON AND TWO-BARYON SYSTEMS. Abidi, S. T. H. (Indian Inst. of Tech., Kharagpur). Indian J. Phys., 42: 465-73(Aug. 1968).

The states belonging to (4,1) irreducible representations of SU_3 are classified by their charge and U-spin. This classification is used to derive mass relations. The probable value of spin J of a baryon-baryon system belonging to (4,1) representation is to be 1. It is also found that ($J^P = 5/2^+$, B = 1) baryon states can only belong to (4, 0, 0, 0, 1) irreducible representation of SU_6. Some branching ratios in the decays $35 \rightarrow 8 \otimes 27$ are calculated. (auth)

32798 DEGENERATE REPRESENTATION FUNCTIONS FOR SO(ν), SU(ν), AND SU(ν) ⊗ SU(ν) AND THEIR ANALYTICAL REDUCTIONS. Delbourgo, R.; Koller, K.; Williams, Ruth M. (Imperial Coll. of Science and Technology, London). J. Math. Phys. (N. Y.), 10: 957-63(June 1969).

The problem of obtaining the rotation matrix elements $d^N(\theta) = \langle N|e^{-i\theta J_2}|N\rangle$ was studied where $|N\rangle$ refer to a particular degenerate class of basis vectors of a symmetry group, G, which embraces the rotations $SU(2)_J$ as a subgroup. For G = SO(ν), SU(ν), and SU(ν) ⊗ SU(ν), it is proven that these particular representation functions are proportional to the Gegenbauer polynomials $C_N^{\lambda(\nu-2)}(\cos\theta)$, $C_N^{\lambda(\nu-1)}(\cos\theta)$, and $C_N^{\lambda\nu}(\cos\theta)$, respectively. The reduction of such functions into one another according to the formula $C_{N'}^{\lambda'} = \Sigma_N a_N C_N^{\lambda}$ was solved in generality for complex values of N and corresponds to the reduction of Regge poles of G into Regge poles of one of its subgroups. The reduction formula for functions of the second type $E_{N'}^{\lambda'} = \Sigma_N b_N E_N^{\lambda}$ was also derived; here one simply meets an infinite series. (auth)

Field Theories

General

Refer also to abstract 32824.

32799 (JINR-P2-4362) VARIATIONAL PRINCIPLE AND NONCONSERVED OPERATORS. Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 33p. (In Russian). Dep.

A variational principle is applied to obtain nonconserved operators in field theory. They are induced by infinitesimal transformations under which the Lagrangian is not invariant. As an example the nonconserved operators are found out as well as the equations for them for translations, rotations, conformal and phase shift transformations of one of the fields from the closed system of interacting fields and also for gauge transformations. (auth)

Quantum Field Theory

Refer also to abstracts 32669, 32674, 32702, and 32735.

32800 (AD-682959) QUANTUM FIELD THEORY AND ELEMENTARY PARTICLES. Final Scientific Report, August 1, 1966–September 30, 1968. Chisholm, S. R. (Kent Univ., Canterbury (England)). Nov. 1968. 9p. (AFOSR-69-186-TR). CFSTI.

Mathematical theory of Pade approximants, application of Pade approximants to renormalizable fields, other applications of Pade approximants, calculation of higher-order matrix elements, and singular potentials and nonrenormalizable fields are discussed. (auth) (USGRDR)

32801 (ITF-69-1) ON REPRESENTATIONS OF THE INHOMOGENEOUS DE SITTER GROUP AND ON EQUATIONS OF THE SCHROEDINGER–FOLDY TYPE. Fushchich, V. I.; Krivskii, I. Yu. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 22p. (CONF-680647-5). Dep.

From Conference on Composite Models of Elementary Particles, Kiev, USSR.

A concrete realization is presented of irreducible representations of the inhomogeneous group P(1,n)-the group of translations and rotations in 1 + n-dimensional Minkowski space in two classes (when $P_0^2 - P_k^2 > 0$ and $P_0^2 - P_k^2 < 0$). All the P(1,n)-invariant equations of the Schrödinger–Foldy type are written down. Some questions of a physical interpretation of the quantum, mechanical scheme based on the inhomogeneous de Sitter group P(1,4) are discussed. (auth)

32802 (JINR-E2-4404) POSSIBLE QUANTIZATIONS. Geyer, Bodo (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 10p. Dep.

For a scalar hermitian field $\phi(x)$ it is shown that besides the well-known possibility at quantization according to para- or superstatistics there are also other ways of quantization which include Bose or Fermi statistics. In particular this can be done by creation and annihilation operators which obey the relations $[a_i a_l^+, a_m^+] = s a_i^+ \delta_{lm}$ where $s = \pm 1$ and the number operator is given by $N_i = s(a_i a_i^+ - p)$, $p = 1,2,\ldots$. The creation and annihilation operators induce a representation of the Lie algebra of the unitary group with $N_{ij} = s a_j a_i^+$ as generators for them. Bose (Fermi) statistics follow for $s = 1(-1)$ and $p = 1$. (auth)

32803 (NYO-3399-191) TACHYONS. Sudarshan, E. C. G. (Syracuse Univ., N. Y. Dept. of Physics). Dec. 1968. 11p. (SU-1206-191; CONF-681214-1). Dep. CFSTI.

From 4th Symposium on Relativistic Astrophysics Southwest Center for Advanced Studies, Dallas, Tex.

The properties of tachyons are described. The theory of special relativity, a new formulation of this theory as applied to tachyons, and the relation of tachyons (traveling faster than light) with particles traveling at or below the speed of light are covered. The switching principle, in which the negative-energy tachyon traveling backward in time can be explained by an emission followed by absorption interpreted as an absorption followed by emission, is described. Also the quantum theory of tachyons, quantization of tachyon fields, detection of tachyons, causality, and cosmological considerations are discussed. (J.F.P.)

32804 NUMERICAL STUDIES OF THE BETHE–SALPETER EQUATION. Kaufmann, William Bailey. Berkeley, Calif., Univ. of California, 1968. 124p.

Thesis.

After summarizing the application of the Rayleigh–Ritz and Schwinger variational principles to the unequal mass ϕ^3 Bethe–Salpeter equation there is presented in graphical and tabular form, the solution of the bound-state problem. The dependence of the coupling-parameter eigenvalue on the exchange mass, external mass ratio, and binding energy is examined in detail for s and p ground states. Mixing of excited levels leading to complex solutions is briefly studied, and some Regge trajectories are also calculated. Scattering phase shifts for unequal-mass scattering were calculated and representative examples given. The fact that certain levels do not appear to contribute to Levinson's theorem is also examined. Finally the foregoing methods are generalized to two-channel systems, and channel phase shifts and inelasticities are computed. (Disser. Abstr.)

32805 A STUDY OF SINGLE, DOUBLE, AND TRIPLE COMPTON SCATTERINGS AS TESTS OF GUAGE-INVARIANT MODIFICATIONS OF QUANTUM ELECTRODYNAMICS. Devine, Robert Thomas. Davis, Calif., Univ. of California, 1968. 100p.

Thesis.

The limitations of gauge-invariant modifications of quantum electrodynamics (QED) are discussed as providing a measure of the extent to which experiment verifies theory. The modifications usually used for the anomalous moment of the muon are shown to give ambiguous results, even for single Compton scattering. A historical review of the previous methods of calculating the single Compton cross section is presented, and possibilities of alternative theories explaining the experimental results are discussed. It is observed that only recently have the experimental results been barely able to distinguish between single Compton scattering from Klein–Gordon particles (spinless electrons) and Dirac particles. The corresponding calculations for double Compton scattering are carried out, and the experiments of McGie, Brady, and Knox are found to be capable of distinguishing between the two theories. The calculation of the triple Compton effect is discussed for the usual spinor theory and the scalar (Klein–Gordon) theory. Computer evaluation of the spinor algebra is considered but it is concluded that the available methods are limited by computer

technology. The process was evaluated for the most probable final state, in which only one photon is hard and the two remaining photons are soft. A discussion of all previous approximations of this type reveals that they have effectively replaced the spinor interaction of the electron and the soft photons with a scalar interaction. These approximations were also carried out for multiple Compton scattering from Klein–Gordon particles. Predictions of both theories are given for the experimental configuration of the proposed experiments. (Disser. Abstr.)

32806 CAUSAL PROPAGATOR AS BOUNDARY VALUE OF THE ANALYTIC FUNCTION IN COORDINATE SPACE. Lukierski, Jerzy (Univ., Wroclaw). Nucl. Phys., B11: 139-51(1969).

The causal propagator is introduced without use of the notation of time ordering. The analog of the Källén–Lehmann spectral function, defined by means of a discontinuity along the cut in the complex coordinate plane is considered. A discussion of the derivatives of the causal propagator is given. It appears that in the general case the wave renormalization constant should be an operator. The definitions of the equal-time limit for the commutator function by means of the causal propagator, introduced in coordinate space by Johnson and Low, and in momentum space by Björken, are discussed. Finally, a calculation of the second-order polarization operator, performed in coordinate space, is presented. (auth)

32807 FEYNMAN RULES AND QUANTUM ELECTRODYNAMICS AT INFINITE MOMENTUM. Chang, Shau-Jin; Ma, Shang-Keng (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 180: 1506-13(Apr. 25, 1969).

The Feynman rules were studied in terms of the new variables $s = p^0 - p^3$, $\eta = p^0 + p^3$, and $q = (p^1, p^2)$ in the ϕ^3 model and in quantum electrodynamics. The connection between the new variables and the dynamics at infinite momentum is established. In the ϕ^3 model, Weinberg's rules at infinite momentum are easily deduced upon integrating over the s variables in the propagators without taking the $p^3 \to \infty$ limit. The new Feynman rules lead to much simpler calculation of the second-order self-energies and the magnetic moment in quantum electrodynamics. It is still unclear if there is advantage in computing higher-order terms in quantum electrodynamics with the new rules. (auth)

32808 COMMENT ON QUANTUM ELECTRODYNAMICS. Gupta, Suraj N. (Wayne State Univ., Detroit). Phys. Rev., 180: 1601-2(Apr. 25, 1969).

It is shown that the supplementary condition in quantum electrodynamics with an indefinite metric is covariant as well as consistent. (auth)

32809 AXIAL-VECTOR CURRENT IN SPINOR ELECTRODYNAMICS. Brandt, Richard A. (Univ. of Maryland, College Park). Phys. Rev., 180: 1490-1502(Apr. 25, 1969).

Adler has shown that in perturbation theory for spinor electrodynamics, suitably regularized, the divergence of the unrenormalized axial-vector current contains, in addition to the expected mass term, a term of the form $\epsilon_{\alpha\beta\gamma\delta} F_{\alpha\beta} F_{\gamma\delta}$. Motivated by this result, the renormalized axial-vector current j_μ^5 is studied. The essentially unique finite local j_μ^5 is explicitly constructed and it is found to be invariant under local gauge transformations. Taking the divergence $\partial_\mu j_\mu^5$ gives the renormalized analog of Adler's additional term. Similar "noncanonical" operator terms are seen to occur in equal-time commutators involving j_μ^5. Although all matrix elements of $\partial_\mu j_\mu^5$ are finite, it is found that the off-shell Green's function $\langle T\partial_\mu j_\mu^5(x)\psi(y)\bar{\psi}(z)\rangle$ is divergent and, correspondingly, that equal-time commutators involving j_μ^5 are in general singular. It is shown that Ward identities can nevertheless be given a meaning. The algebraic properties of j_μ^5 are seen to be reflected in the scattering amplitudes of the theory. Renormalized integral representations of axial-vector vertices are constructed, and radiative corrections to weak interaction are discussed. The axial-vector currents in other spinor models are discussed. (auth)

32810 QUANTUM FIELD THEORY AT INFINITE MOMENTUM. Tiktopoulos, George (Princeton Univ., N. J.). Phys. Rev., 180: 1414-16(Apr. 25, 1969).

Within the framework of conventional quantum field theory, the (formal) transition to an infinite momentum frame leads to a dynamics based on M^2, the mass-squared operator, rather than the Hamiltonian. A class of theories (in one space dimension) is presented, for which M^2 is a positive operator densely defined on the Hilbert space of physical states. The latter coincides with the space of bare states. Accordingly, Hilbert-space methods can be used to further investigate the physical content of these theories (auth)

32811 MASSLESS PARTICLES AND FIELDS. Frishman, Y.; Itzykson, C. (Stanford Univ., Calif.). Phys. Rev., 180: 1556-71(Apr. 25, 1969).

Free fields of massless particles transforming covariantly under the Poincaré group are constructed. The allowed infinite- and finite-dimensional representations of the Lorentz group are obtained. The wave functions are calculated in these representations in various bases. The commutation rules are computed, and turn out to be nonlocal for any infinite-dimensional fields. The transformation law of a certain irreducible infinite-dimensional representation is shown to coincide, for its lowest-spin component, with the usual radiation-gauge, vector-potential transformation law, as already discovered by Bender. (auth)

32812 CURRENT ALGEBRAS, SUM RULES, AND CANONICAL FIELD THEORIES. Cocho, G. (International Centre for Theoretical Physics, Trieste, Italy); Fronsdal, C.; White, R. Phys. Rev., 180: 1547-55(Apr. 25, 1969).

A very large class of c-number Lagrangian field theories, called canonical field theories—being all theories whose field equations have sufficiently many solutions—satisfy a number of important completeness relations. These relations ensure the existence of Gell–Mann current algebras and Fubini sum rules, and guarantee that canonical field quantization is possible. Finite-component, first- and second-order Lagrangians in general, and a class of fourth-order Lagrangians are studied. The work is preliminary to an investigation of infinite-component field theories. (auth)

32813 UNITARY S-MATRIX IN THE LEE MODEL WITH "DIPOLE-GHOST" AND AN EQUIVALENT MODEL. Karowski, M. (Institut fuer Theoretische Physik, Hamburg). Z. Naturforsch., 24a: 510-15(Apr. 1969). (In German).

The N–2Θ-sector of the Lee-model is solved in the special case of the "dipole-ghost," and a unitary S-matrix is constructed. A general instruction is presented to construct the physical subspace of the whole state space with indefinite metric. This method is always applicable, if there are couples of "good" and "bad" ghosts. Another model with positive definite state space is described, which has the same S-matrix as the Lee-model with "dipole-ghost"$_2$ in the N–Θ- and N–2Θ-sector. (auth)

32814 PROPAGATOR METHOD IN LATTICE SPACE THEORY. Weidemann, Erich G. (Univ., Munich). Z. Naturforsch., 24a: 499-510(Apr. 1969). (In German).

The Feynman diagrams and rules of a field theory with local four fermion coupling are transformed into a theory of interacting fermions in a finite dimensional Hilbert space constructed on Z^3 points of a cubic lattice. The propagator is derived for the lattice space theory and the formal similarity and the qualitative differences are discussed and compared with conventional field theories. The mass produced by the interaction is calculated by compensation of the first order self-energy diagrams (Hartree–Fock-approximation). The solution for coupling constant $W > 0$ violates the chiral symmetry, the solution for $W < 0$ the cubic symmetry of the theory. The second order corrections to the mass operator are calculated. They diverge in the limit $Z \to \infty$ like $\sqrt{Z}$ if W is proportional to $\sqrt{Z}$ which is necessary for a finite mass in the HF-approximation. Under the same assumption the maximum divergence is like $\sqrt{Z}$ in any order of the perturbation theory. The mass operator is finite including second order contributions if W is proportional to $\sqrt[4]{Z}$. In this case the higher order contributions decrease like $\sqrt{Z^{-(n/2-1)}}$. (auth)

32815 WIGHTMAN FORMULATION FOR NONLOCALIZED FIELD THEORY. I. Iofa, M. Z.; Fainberg, V. Ya. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1644-56 (May 1969). (In Russian).

It is shown that in nonlocalized theories with exponential growth of vacuum mean values in momentum space the Wightman functions retain a number of properties characteristic of localized field theories. It is found that the holomorphic region of the functions in coordinate space include real points, the Jost points. The existence of Jost points permits one to introduce the concept of quasilocalizability, to prove the theorem of equivalence between weak local commutativity and CPT-invariance and also the relation between the spin and statistics. The existence of asymptotic states is proven for a special class of nonlocalized theories. (auth)

32816 HARMONIC ANALYSIS ON THE POINCARE GROUP. I. GENERALIZED MATRIX ELEMENTS. Hai, Nghiem Xuan (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Commun. Math. Phys., 12: 331-50(May 6, 1969).

The generalized matrix elements of the unitary representations of the Poincaré group are computed as eigendistributions of a complete commuting set of infinitesimal operators on the group. The unitary representations of the Poincaré group can be reconstructed from these matrix elements in a Hilbert space of square integrable functions over the space of eigenvalues. Some properties of these distributions (which are measures) are given

and some characters are computed from the explicit formulas for the matrix elements. (auth)

32817 A REMARK ON ASYMPTOTIC COMPLETENESS OF LOCAL FIELDS. Rinke, Max (Eidgenoessische Technische Hochschule, Zurich). Commun. Math. Phys., 12: 324-30(May 6, 1969).

Assuming the existence of an asymptotically complete Wightman field with nontrivial S-matrix, a local field is constructed such that the Haag-Ruelle scattering theory applied to this field leads to $H_{in} \neq H$ and $H_{in} \neq H_{out}$. (auth)

32818 THE FORM OF REPRESENTATIONS OF THE CANONICAL COMMUTATION RELATIONS FOR BOSE FIELDS AND CONNECTION WITH FINITELY MANY DEGREES OF FREEDOM. Hegerfeldt, G. C.; Melsheimer, O. (Univ., Marburg, Ger.). Commun. Math. Phys., 12: 304-23(May 6, 1969).

Given a representation of the canonical commutation relations (CCR) for Bose fields in a separable (or, under an additional assumption, nonseparable) Hilbert space H it is shown that there exists a decreasing sequence of finite and quasi-invariant measures μ_n on the space V′ of all linear functionals on the test function space V, $\mu_1 \geq \mu_2 \geq \ldots$, such that H can be realized as the direct sum of the $L^2_{\mu_n}$, the space of all μ_n-square-integrable functions on V′. In this realization U(f) becomes multiplication by $e^{i(F,f)}$, $F \in V'$. The action of V(g) is similar as in the case of cyclic U(f). But different $L^2_{\mu_n}$ can be mixed now. Simply transcribing the results in terms of direct integrals one obtains a form of the representations which turns out to be essentially the direct integral form of Lew. All results are independent of the dimensionality of V and hold in particular for dim V < ∞. Thus one has obtained a form of the CCR which is the same for a finite and an infinite number of degrees of freedom. From this form it is in no way obvious why there is such a great distinction between the finite and infinite case. In order to explore this question the von Neumanns theorem about the uniqueness of the Schrödinger operators is derived in a constructive way from this dimensionally independent form and it is shown explicitly at which point the same procedure fails for the infinite case. (auth)

32819 RELATIVISTIC "SPREADING" POINT CHARGE. Ershov, R. E. (Inst. of Physics, Novosibirsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 25-33(1968). (In Russian).

It is concluded that the interaction of charges, which create a field with a potential proportional to $1/r^n$, leads to a relative velocity greater than the speed of light. It is possible to eliminate this if one changes from point to volumetric charges. Formulas are given for calculating the density of such volumetric charges for arbitrary N. The volumetric charge, which replaces the point charge in the relativity theory calculation, has a form of either a nucleus with gradually decreasing density or a diffuse spherical envelope. (tr-auth)

32820 RELATION BETWEEN THE CLASSICAL THEORY OF FLUCTUATIONS AND QUANTUM FIELD THEORY. Marshall, T. U. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 34-9(1968). (In Russian).

It was previously shown that the primary state of the harmonic oscillator can be represented by the motion of a classical charged particle under the influence of a fluctuating electromagnetic field on condition that the classical radiation reaction is considered. This work is reviewed, and new results are obtained for the extension of this method to excited states. (tr-auth)

32821 POSSIBILITY OF PHYSICAL SINGLE-PARTICLE STATES IN A GENERALIZED LEE MODEL. Gostev, V. B.; Mineev, V. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 8-14(Mar.-Apr. 1969). (In Russian).

A study is made of whether the unstable single-particle states correspond to resonances in elastic scattering in quantum field theory models with three fixed sources (Lee-type model). It is shown that in this model there is a greater variety of stable and unstable states not having analogs in the model. Nonexponential decay is possible (with the corresponding selection constant). (tr-auth)

32822 GOLDSTONE THEOREM IN AXIOMATIC APPROACHES. Bulinskii, A. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 75-9(Mar.-Apr. 1969). (In Russian).

A variant of the Goldstone theorem proposed previously is transformed theoretically satisfying the axiom of Whiteman or Jaffe. In the absence of a massless particle with local conserved current, given for local states, it is possible to relate the symmetry, which was not spontaneously broken, not postulating bound automorphic fields with current. (tr-auth)

Gravitation and General Relativity

32823 (AD-839443) COMPLEX GRAVITATION. Gleyzal, Andre (Naval Ordnance Lab., White Oak, Md.). July 31, 1968. 30p. (NOLTR-68-112). CFSTI.

A mathematical basis for complex gravitation is formulated. Its application to mathematical physics is indicated. The theory unifies in a complex Riemannian geometry, general gravitational relativity, electromagnetism and possibly nuclear fields. Geodesics of gravitational theory are replaced by m-geodesics to represent "classical" electrodynamics. (auth) (USGRDR)

32824 GRAVITATIONAL WAVES IN GENERAL RELATIVITY. X. ASYMPTOTIC EXPANSIONS FOR THE EINSTEIN-MAXWELL FIELD. van der Burg, M. G. J. (Univ. of York, Eng.). Proc. Roy. Soc. (London), Ser. A, 310: 221-30(May 6, 1969).

Asymptotic expansions are given for the Einstein-Maxwell field representing radiation of gravitational and electromagnetic energy from a bounded source of matter and charge. It is shown that the flow of radiation is determined by four news functions which can be considered as two functions giving the gravitational part of the news and two for the electromagnetic part. Together with initial data specified on a null cone these four functions completely determine the behavior of the system. It is shown that the gravitational and electromagnetic news functions contribute separately to a decrease in the mass of the source. The Newman-Penrose conserved quantities are obtained and an interpretation of the invariant λ-function is given. (auth)

32825 SPECIFYING SOURCES IN GENERAL RELATIVITY. Stachel, John (Boston Univ.). Phys. Rev., 180: 1256-61 (Apr. 25, 1969).

It is demonstrated that the dynamical equations for a massless scalar field, incoherent matter, or incoherent radiation may be put into such forms that they may be solved without a metric. The equations reduce to the usual forms when four conditions on the form of the metric are imposed, which do not restrict its nature. The conservation laws $\tilde{T}^{\nu}_{\mu;\nu} = 0$ are thereby satisfied before the integration of the Einstein equations is attempted, ensuring that solutions will exist. The equations of motion of a perfect fluid in isentropic flow are similarly reformulated nonmetrically; but since five conditions must be placed on the metric to reduce the theory to its usual form, there is one real restriction on the metrical geometry implied in this case. (auth)

32826 EQUIVALENCE PRINCIPLE FOR MASSIVE BODIES INCLUDING ROTATIONAL ENERGY AND RADIATION PRESSURE. Nordtvedt, K. Jr. Phys. Rev., 180: 1293-8(Apr. 25, 1969).

The Einstein gravitational theory and the Brans-Dicke gravitational theory are investigated for the gravitational-to-inertial mass ratio (m_g/m_i) they yield for massive systems. Models are examined for stars in equilibrium but undergoing rotation or containing electromagnetic radiation. General conditions on the space-time metric of many mass sources are obtained which lead to $m_g/m_i = 1$ for the massive systems. It is found that $m_g/m_i \neq 1$ for a nonrotating star in the Brans-Dicke theory. The violation is of order 10^{-6} for the Sun. In the Brans-Dicke theory there are also contributions to $m_g/m_i \neq 1$ due to the radiation content of a star. This violation is of order (radiation energy)/(stellar mass), yielding a correction of about 10^{-3} for the Sun. (auth)

32827 FORCE ON AN ELECTRON NEAR A METAL IN A GRAVITATIONAL FIELD. Harrison, W. A. (Stanford Univ., Calif.). Phys. Rev., 180: 1606-7(Apr. 25, 1969).

The three principal theoretical treatments of the force on an electron near a metal in a gravitational field are briefly reviewed, and the central arguments restated. The essential conclusion is that the current theory of metal surfaces conflicts with the apparent experimental findings of Witteborn and Fairbank, but agrees with recent experiments by Beams. A simpler experiment, directed at this specific problem, is proposed. (auth)

32828 ESTABLISHMENT OF THE LORENTZ GROUP ALONE WITH SYMMETRY AND RELATIVITY ASSUMPTIONS. Suessmann, G. (Univ., Munich). Z. Naturforsch., 24a: 495-8(Apr. 1969). (In German).

From the relativity principle without application of the empirical principles from the constant of light velocity, it follows that the Lorentz transformation is the single conceivable alternative to the (space-time asymmetrical) Galilei-transformation. (tr-auth)

32829 NATURE OF THE SINGULARITIES IN THE GENERAL SOLUTIONS OF THE GRAVITATIONAL EQUATIONS. Belinskii, V. A.; Khalatnikov, I. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1700-12(May 1969). (In Russian).

A general solution of the gravitational equations which contained a fictitious singularity was investigated previously. A solution with a physical singularity was found which was deficient with respect to an arbitrary function which would make it a general solution. It is investigated in which way inclusion of the deficient function as a perturbation may, during evolution of the solution with a physical singularity, destroy it and yield a fictitious singularity. (auth)

32830 EVIDENCE FOR DISCOVERY OF GRAVITATIONAL RADIATION. Weber, J. (Univ. of Maryland, College Park). Phys. Rev. Lett., 22: 1320-4(June 16, 1969).

Coincidences have been observed on gravitational-radiation detectors over a base line of about 1000 km at Argonne National Laboratory and at the University of Maryland. The probability that all of these coincidences were accidental is incredibly small. Experiments imply that electromagnetic and seismic effects can be ruled out with a high level of confidence. These data are consistent with the conclusion that the detectors are being excited by gravitational radiation. (auth)

32831 THREE-DIMENSIONAL "RELATIVITY" FOR AXISYMMETRIC STATIONARY SPACE-TIMES. Perjes, Z. (Central Research Inst. for Physics, Budapest). Commun. Math. Phys., 12: 275-82(May 6, 1969).

The equivalence of the axisymmetric stationary vacuum gravitational field problem to a 3-dimensional "relativity theory" in the presence of a certain scalar matter field is shown. An invariant classification can be achieved with respect to the algebraic structure of the 3-dimensional trace-free Ricci-tensor. The extension of these results to electrovac spaces is also discussed. (auth)

32832 QUADRATIC ACTION PRINCIPLE OF RELATIVITY. Lanczos, C. (Dublin Inst. for Advanced Studies, North Carolina State Univ., Raleigh). J. Math. Phys. (N. Y.), 10: 1057-65(June 1969).

By an improved mathematical technique, the field equations derivable from a Lagrangian which is quadratic in the curvature components can now be studied in greater detail. The intercalation of a high-frequency metrical plateau between the flat Minkowskian metric and the macroscopic physical world has the consequence that the resulting perturbation equations are no longer of fourth but only of second order, thus making a comparison with Einstein's equations possible. The principal difference is that the free vector of Einstein's theory is now restricted by a divergence condition, with the result that the equations of the electromagnetic field, expressed in terms of the vector potential, become solutions of the macroscopic field equations. The cases of fourfold symmetry with imaginary time and 3 + 1 symmetry with real time are discussed The gravitational phenomena and the second-order interaction terms, needed for the construction of material particles, remain outside the limits of the present investigation. (auth)

32833 GEOMETRIZATION OF THE BRANS-DICKE SCALAR FIELD. Peters, P. C. (Univ. of Washington, Seattle). J. Math. Phys. (N. Y.), 10: 1029-31(June 1969).

The Brans-Dicke gravitational scalar field is geometrized in the spirit of the Rainich-Misner-Wheeler geometrization of electromagnetism. Geometric equations are derived which imply that the Brans-Dicke field is present and an explicit expression is given for this field in terms of geometrical quantities. (auth)

32834 SOLUTION OF THE PROBLEM ON THE STRUCTURE OF GRAVITATIONAL SYSTEMS WITH ELLIPSIODAL VELOCITY DISTRIBUTION. Burdyugov, A. D. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 98-100(Mar.-Apr. 1969). (In Russian).

Two solutions are found for the density distribution problem in gravitational systems of particles with axial symmetry, considering functions of the velocity distribution to be ellipsoidal. Formulas are given, which according to observational data, permit rotational parameters to be determined: the second temperature and the angular rotation ω_3. The effective radii of the obtained cylindrical formations were determined on the basis of the Vlasov integral equation of state. (tr-auth)

Scattering Theory

Refer also to abstracts 32644, 32780, and 32804.

32835 (JINR-E2-4417) ON THE UNITARITY OF THE S-MATRIX IN THE METHOD OF THE QUASIPOTENTIAL. Bogolubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 10p. Dep.

The quasipotential equation for high-energy scattering was considered. It is proved that if the antihermitian part of the quasipotential is positive, the scattering matrix is "underunitary," $S^+S \leq 1$. (auth)

32836 EFFECT OF THE EXISTENCE OF THE ELEMENTARY QUARK ON HIGH ENERGY SCATTERING. Anderson, Suart Duerr. Berkeley, Calif., Univ. of California, 1968. 46p. Thesis.

An elementary quark, if supposed to exist and to couple in quark-antiquark pairs to ordinary two-particle channels, gives rise to a Regge trajectory which would dominate high energy scattering at large momentum transfer. A simple model theory embodying these features is presented. Specifically, the model assumes a single scalar-scalar pair to represent the ordinary two particle channel which is observed, coupling to a spinor-spinor channel of large mass, and simple pole-type potentials approximated in the effective range method. The Regge trajectory and subtraction generated by this coupling are computed, and arguments given concerning their contribution to the cross section. Comparison with proton-proton scattering suggests that if such an elementary particle exists, its mass must be greater than about 10 GeV. (Disser. Abstr.)

32837 REGGE-POLE FAMILIES AND TOLLER POLES: $t \neq 0$. Di Vecchia, P. (CNEN, Rome. California Inst. of Tech., Pasadena); Drago, F. Contracts F61052 67 V 0084; AT(11-1)-68. Nuovo Cim., 61A: 421-37(June 1, 1969).

Mass formulas for M = 0 and M = 1 Toller families are derived using the standard tools of the S-matrix theory. (auth)

32838 ASYMPTOTIC EXPANSION OF HIGH-ENERGY UPPER BOUNDS OF THE SCATTERING AMPLITUDE. Cheung, F. F. K. (State Univ. of New York, Stony Brook). Nuovo Cim., 61A: 438-48(June 1, 1969).

A family of asymptotic expansions for the Froissart-Martin bound is obtained. It is shown that incorporation of the second term in the asymptotic expansions brings the Froissart-Martin bound to closer agreement with experiment. (auth)

32839 FROISSART BOUNDS WITH ANY SPIN. Bell, J. S. (CERN, Geneva). Nuovo Cim., 61A: 541-52(June 1, 1969).

For elastic scattering of particles of arbitrary spin, an invariant amplitude is constructed which has the "positivity" required for Martin's proof of Froissart bounds. (auth)

32840 PHASE CONTOURS OF SCATTERING AMPLITUDES. Tan, Chung-i. Berkeley, Calif., Univ. of California, 1968. 80p. Thesis.

Phase contours are used to study consistency conditions for a symmetric scattering amplitude having a given high-energy behavior. The latter is taken to correspond to dominance by Regge poles that have continuously rising trajectories. By means of crossing symmetry a sequence of real zeros of the amplitude, that lie along lines of symmetry in the model, s = u, in t < 0 are introduced, for example. The leading zero in this sequence is related to the scattering length. Under quite general conditions these zeros may be related, via complex surfaces of zeros, to the zeros of Regge residues below threshold. By considering complex sections of phase contour surfaces, it is shown that these zeros may also be related to a sequence of zeros at complex points, that are due to interference between resonance poles on unphysical sheets above threshold. (Disser. Abstr.)

32841 KINEMATICAL CONSTRAINTS AT t = 0 FOR REGULARIZED HELICITY AMPLITUDES: THE EQUAL-UNEQUAL-MASS CASE. Paciello, M. L.; Taglienti, B. (Univ., Rome). Nuovo Cim., 61A: 457-62(June 1, 1969).

Using the behavior of the transversity amplitudes near t = 0, it is found that some linear combinations of regularized helicity amplitudes and their derivatives at this point have to vanish. The calculation is performed for the EU-mass case in the general spin configuration. (auth)

32842 LARGE-ANGLE AND LARGE-MOMENTUM-TRANSFER LOWER BOUNDS FOR THE DIFFERENTIAL CROSS SECTION IN THE LEHMANN ELLIPSE AND THE MANDELSTAM CUT-PLANE CASES. Ciulli, S. (CERN, Geneva). Nuovo Cim., 61A: 463-85(June 1, 1969).

Exact expressions for the lower bounds of the maximum of the scattering amplitude of differential cross section between two (complementary) constant angles, as well as between t = const and u = const are derived using the Nevanlinna principle, both for finite energies as in the high-energy limit. Computations were performed for two distinct assumptions about the analyticity domain of the scattering amplitude: for the shrinking ellipse of Lehmann and for the Mandelstam cosine cut complex plane. (auth)

32843 ASYMPTOTIC UNITARITY CONDITIONS AND HIGH-ENERGY BEHAVIOR OF SCATTERING AMPLITUDES. Bas-

setto, A.; Paccanoni, F. (Univ., Padua). Nuovo Cim., 61A: 486-98(June 1, 1969).

A model for diffraction scattering is studied where the Pomeranchukon is replaced by a fixed branch point in the angular-momentum plane, of square-root type, generated from the saturation of asymptotic unitarity both in the direct and in the crossed channel. The analytical properties of the continued partial-wave amplitude are explored and consistency is found with the crossing-symmetry requirement. Finally the physical predictions of this model are discussed paying particular attention to the πN elastic scattering and charge-exchange polarization. (auth)

32844 S-MATRIX INPUTS AND RESONANCE PARAMETERS. Chung, Sung Chae. Athens, Ohio, Ohio Univ., 1968. 93p.

Thesis.

In bootstrap dynamics, the most commonly adopted method is the "N/D" method. The reason for this popularity is basically that its formalism assures the correct unitarity and analyticity properties of the relativistic partial-wave scattering amplitude. It is assumed that the amplitude has the following fundamental properties: unitarity, analyticity, and crossing symmetry. In addition, the S-matrix is a Lorentz invariant, having the singularities required by unitarity (maximal analyticity). The main concern was elastic collisions with equal mass. The well-known "N/D" method was used in order to investigate the resonance behavior of the partial-wave amplitude. The whole left hand cut of the amplitude was replaced by two input-poles constrained to satisfy a threshold requirement. The necessary and sufficient conditions for resonance were derived and it was seen that a narrow resonance is indeed possible. Since the dynamics of crossed channels give rise to the driving force which makes the reaction in the direct channel possible, the mechanism and formalism of the crossed channels were discussed. Using these ideas, the position of the input-poles was adjusted to represent a crossed channel resonance. As one of the most interesting results it is shown that it is indeed possible to obtain a narrow resonance, but only by making the position parameters of the input-poles large. It is also shown that a "simple" bootstrap mechanics fails to provide a self-generating rho-meson. This result strongly implies that for such a calculation one has to take into consideration processes other than the $\pi\pi$ channel such as $\pi\pi \simeq \pi\omega$, $\pi\pi \simeq k\bar{k}$, $\pi\pi \simeq N\bar{N}$. However, with more complicated forces, the left hand cut would have to be replaced by three or more poles as inputs instead of two input-poles as was done in this work. This, however, introduces more free parameters and increases the difficulty of deducing physically meaningful conclusions. (Disser. Abstr.)

32845 CONSISTENCY CONDITION FOR CROSSING SYMMETRIC REGGE BEHAVED AMPLITUDES. Hoyer, Paul (Univ., Helsinki). Nucl. Phys., B11: 93-8(1969).

A necessary condition is derived for crossing symmetric Regge behaved amplitudes with one linearly rising trajectory. The condition is a set of linear equations correlating the residues at different poles. In a particular case the condition implies a unique amplitude, which for certain external masses reduces to the models proposed by Veneziano and Virasoro. (auth)

32846 CROSSING MATRIX FOR PROCESSES INVOLVING MASSLESS PARTICLES. Fox, J. R. (Imperial Coll. of Science and Tech., London). Nucl. Phys., B11: 186-94(1969).

Using the covariant helicity formalism, the crossing matrix for processes involving massless particles is derived and it is found as usual, that the helicity of a massless particle changes from one channel to the other if and only if it is ingoing in one and outgoing in the other. It is shown that, for consistency in the definitions of the cosines of the crossing and center-of-mass scattering angles, the functions $\sqrt{[x-(m_i+m_j)^2][x-(m_i-m_j)^2]}$ for $m_i = 0$ must be taken to be analytic. (auth)

32847 RISING REGGE TRAJECTORIES AND DYNAMICAL CALCULATIONS. Mandelstam, Stanley (Univ. of California, Berkeley). Comments Nucl. Particle Phys., 3: 65-72(May-June 1969).

A plausibility argument is given for supposing that Regge trajectories may rise indefinitely. It is then indicated how dynamical calculations for a system with such trajectories might be performed. (J.F.P.)

32848 DAUGHTERS, CONSPIRACIES, AND LORENTZ SYMMETRY. II. Bitar, Khalil M. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 180: 1477-82(Apr. 25, 1969).

A recently proposed model for the contribution of Regge-pole families to helicity amplitudes at $t = 0$ is discussed further. The main feature of the models is that at $t = 0$ it allows a smooth transition between all mass configurations. It is shown that the sum over daughters, when normalized to a Lorentz pole, automatically satisfies the equal-unequal-mass $t = 0$ conspiracy relations. The model is then studied at arbitrary values of t. Pseudothreshold and normal threshold conspiracy relations are shown to be satisfied, provided simple conditions on the dynamical residues are imposed. The main features of the model near $t = 0$ are then presented through the use of an example. (auth)

32849 MANDELSTAM SYMMETRIES IN THE COMPLEX ANGULAR MOMENTUM PLANE. Freeman, David F. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 180: 1457-62(Apr. 25, 1969).

A symmetry found by Mandelstam in the complex l plane for potential scattering is investigated. One consequence of the symmetry is given in the form of logarithmic finite-energy sum rules. A series of proofs of the symmetry for potential scattering is given, culminating in ones using methods that are applicable to off-energy-shell and relativistic scattering. In both these latter cases, this symmetry is disproven in contrast to the more well-known Mandelstam symmetry, which is seen to hold there. (auth)

32850 REGGE POLES, ARGAND DIAGRAMS, AND RESONANCES. Kugler, M. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 180: 1538-40(Apr. 25, 1969).

Loops in the Argand diagram of s-channel partial-wave projections of Regge poles are investigated. In attempting to identify these with resonances, strong constraints on both Regge poles and resonances are deduced. (auth)

32851 SPINOR AMPLITUDES IN THE INVARIANT SPACE: ANALYTICITY, UNITARITY, CROSSING, AND CONSTRAINTS. Hwa, Rudolph C. (Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., 180: 1588-1600(Apr. 25, 1969).

The spinor amplitudes in the momentum space have simple properties in analyticity, unitarity, and crossing symmetry. For the purpose of dispersion analysis, it is more convenient to work in the space of the scalar invariants. However, by going over to the invariant space, kinematical singularities are introduced. Regularized spinor amplitudes are constructed which are free of any kinematical singularities, but not of kinematical zeros. The unitarity equation in terms of these amplitudes is derived explicitly. Their crossing relation is obtained and is simple. The merits and drawbacks of these spinor amplitudes are compared with those of the helicity amplitudes and of the invariant amplitudes. None of these formalisms is simple in all aspects of the dynamical and kinematical properties. (auth)

32852 FINITE-ENERGY SUM RULES AND INFINITE SEQUENCE OF DAUGHTER TRAJECTORIES. Swift, Arthur R.; Tucker, Robin W. (Univ. of Massachusetts, Amherst). Phys. Rev. Lett., 22: 1411-13(June 23, 1969).

It is shown that an infinite set of daughter trajectories is required to saturate finite-energy sum rules consistently. In the presence of this infinite set, the sum rules by themselves do not constrain the energy dependence of the trajectory function. (auth)

32853 INDETERMINACY POINTS IN POTENTIAL SCATTERING. Aly, H. H. (International Centre for Theoretical Physics, Trieste, Italy); Schilcher, K.; Mueller, H. J. W. Nuovo Cim., Lett., 1: 707-12(May 11, 1969).

A simple method is presented which yields analytic expressions, in the sense of asymptotic expansion, for the positions of indeterminacy points of the scattering amplitude. (J.F.P.)

32854 GENERALIZED BETHE-SALPETER EQUATIONS FOR COUPLED TWO- AND THREE-BODY AMPLITUDES. Schwartz, Charles (Univ. of California, Berkeley). pp 147-94 of Three-Particle Scattering in Quantum Mechanics. Gillespie, J.; Nuttall, J. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Conference on Three-Particle Scattering in Quantum Mechanics, College Station, Tex. See CONF-680429.

The discussion of the generalized Bethe-Salpeter equations for coupled two- and three-body amplitudes covers coupled equations in graphical form and a numerical analysis. It is shown how to overcome the problem of miscounting graphs, and it is found that the numerical aspects of the three-body problem are thoroughly tractable. (J.F.P.)

32855 REVIEWS OF THE RELATIVISTIC ASPECTS OF THE THREE-BODY PROBLEM. I. PRACTICAL COMPUTATIONS. II. FORM FACTORS IN S-MATRIX THEORY. Omnes, R. L.; Basdevant, J. L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 95-145 of Three-Particle Scattering in Quantum Mechanics. Gillespie, J.; Nuttall, J. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Conference on Three-Particle Scattering in Quantum Mechanics, College Station, Tex. See CONF-680429.

A review is given of practical approaches to relativistic three-body calculations. The ND^{-1} approach to the three-body problem by Mandelstam is reviewed using the computation of form factors as an example. Also the results of a recent extension of this technique to the n-body problem are given. (J.F.P.)

32856 ANALYTICITY PROPERTIES OF NONRELATIVISTIC THREE-PARTICLE SCATTERING AMPLITUDES. Sugar, R. L. (Univ. of California, Santa Barbara). pp 65-94 of Three-Particle Scattering in Quantum Mechanics. Gillespie, J.; Nuttall, J. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Conference on Three-Particle Scattering in Quantum Mechanics, College Station, Tex. See CONF-680429.

The three-body amplitude is used to study the on-energy-shell scattering amplitude directly. Analyticity properties of the three-particle scattering amplitude are studied using nonrelativistic potential scattering. The scattering of three spinless, nonrelativistic particles interacting via a superposition of two-body Yukawa potentials is considered. (J.F.P.)

32857 VARIATIONAL PRINCIPLES AND THE THREE-BODY PROBLEM. Spruch, Larry (New York Univ., N. Y.). Contracts Nonr-285(49); NR012-109. pp 1-64 of Three-Particle Scattering in Quantum Mechanics. Gillespie, J.; Nuttall, J. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Conference on Three-Particle Scattering in Quantum Mechanics, College Station, Tex. See CONF-680429.

The computational aspect of variational principles are discussed. This discussion covers the bound-state problem, scattering theory, transition amplitudes and semiclassical scattering theory, resonances, matrix elements of an arbitrary operator, threshold behavior of cross sections, and variational and simple bounds. (J.F.P.)

32858 SUFFICIENT CONDITIONS FOR STABILITY OF THE FADDEEV EQUATIONS. Zachary, W. W. (Naval Research Lab., Washington, D. C. J. Math. Phys. (N. Y.), 10: 1098-1104(June 1969).

Functional analysis techniques are used to obtain stability theorems for the Faddeev equations in the quantum-mechanical three-particle nonrelativistic scattering theory. Sufficient conditions are obtained in order that the solutions of these equations not be sensitive to small variations of the off-shell two-particle amplitudes. These conditions provide criteria for the validity of some of the previous formal investigations of the Faddeev equations. (auth)

32859 GILBERT-SCHMIDT EXPANSION FOR TWO-PARTICLE POTENTIAL SCATTERING AMPLITUDE. Narodetskii, I. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1086-96(May 1969). (In Russian).

The Gilbert–Schmidt expansion for the two-particle potential scattering amplitude is considered on and off the energy shell. This expansion leads to results equivalent to the Weinberg method and corresponds to introduction of an infinite number of quasiparticles. In practice the number of quasiparticles equals to kr_0, where $k = \sqrt{E}$ and r_0 is the potential range. The results are generalized to the case of noncentral (in particular, tensor) forces. The Gilbert–Schmidt expansion for the amplitude on the energy shell is shown to be analogous to the conventional dispersion theories having however some advantages. Potentials allowing exact solutions are considered as examples. Numerical calculations are carried out for the Hulthen potential. (auth)

Particle Accelerators

Refer also to abstracts 31591, 32483, 32487, 32777, 32884, and 32893.

32860 (BNL-13710) FIRST ORDER BEAM DYNAMICS PROGRAMS USING LINEARIZED SPACE-CHARGE FORCES. PART I. SYSTEMS WITHOUT LINEAR COUPLING TERMS. PART II. SYSTEMS WITH LINEAR COUPLING TERMS. Oleksiuk, L. (Brookhaven National Lab., Upton, N. Y.). Mar. 15, 1969. 15p. Dep. CFSTI.

A series of computer programs called YALO1, YALO2, and YALO3 for the numerical solution of a set of coupled differential equations known as the envelope equations for the phase-space ellipse parameters of a beam of particles subject to linear space-charge forces is described. These programs are used to calculate the beam dimensions of a proton beam passing through a series of linear elements, assuming a linear model for the beam space-charge forces. All dispersive effects in bending magnets are suppressed, so that they are treated only as thick lenses. Also, the computer program ENDLES for numerical integration of the envelope equations for dispersive linear element systems, including relativistic linearized space-charge effects, is described. This program extends the concept of envelope equations to include the dynamics of systems that have linear coupling terms such as occur in bending magnets due to dispersion and in rotated quadrupoles. Path length difference effects to first order can also be treated in this extended formalism. The programs are written in FORTRAN IV. (W.H.K.)

32861 (CEA-R-3677) MAINTENANCE OF THE RESONANCE IN A CAVITY FILLED WITH A VARIABLE DENSITY PLASMA. Melin, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1969. 99p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Orsay, France.

A study has been made of the possibility of keeping in resonance a cavity filled with a plasma of variable density; only the low hf power zone has been examined (less than a few dozen W). A calculation is first made, for the chosen experimental conditions, of the slipping of the resonance frequency of a cavity as a function of the plasma parameters (density, temperature), with a view to obtaining an idea of its importance. A description is then given of the experimental set-up: the S band cavity (3000 Mc) is supplied by a carcinotron type generator; use is made of the plasma of a positive column whose density ($\sim 10^{11}$ cm^{-3}) can easily be controlled so as to obtain slipping of the cavity frequency ($\Delta F_{max} \sim$ 50 Mc). The zone of automatic agreement thus obtained for the S band is 3 per cent continuously ($\sim$100 Mc) and 1 per cent ($\sim$30 Mc) with a response time of 10 μsec (sudden changes in density $\Delta n \sim 5 \times 10^{10}$ cm^3). These characteristics already compare very favorably with existing systems, and can easily be improved. (auth)

32862 (CERN-Trans-69-9) METHOD OF DETERMINATION OF THE ACCELERATION REGIME OF THE IFVE PROTON SYNCHROTRON INJECTOR. Afonin, A. G.; Il'evskii, S. I.; Kapchinskii, S. I.; Popinenkova, I. M.; Teplyakov, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report IFVE-INZH-68-49-K. 23p. (In French). Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 21183. (W.H.K.)

32863 (DNPL/P-8) RADIOACTIVITY INDUCED BY HIGH-ENERGY ELECTRONS. Saxon, G. (Daresbury Nuclear Physics Lab. (England)). Apr. 1969. 11p. (CONF-690320-2). Dep.

From Conference on Radiation Protection in Accelerator Environments, Chilton, England.

Reference is made to induced radioactivity problems consequent to the operation of the NINA 5-GeV electron synchrotron at Daresbury. All modes of operation lead to activation of machine parts to a greater or lesser extent. The principal activities are caused by photonuclear reactions, arising from photons in the showers produced when high energy electrons or photons strike a material. Since there was some doubt about the validity of the equation used for track length at energies in the region of the giant resonance, an alternative approach was adopted, using Monte Carlo calculations of the numbers of photons in a shower as a function of material depth. Activation was assessed in stainless steel, iron and copper. (UK)

32864 (IFVE-OP-68-62) MAGNETIC CHARACTERISTICS OF THE DEFLECTING MAGNET AND QUADRUPOLE LENSES FOR BEAM FORMING IN THE PROTON SYNCHROTRON AT THE INSTITUTE FOR HIGH ENERGY PHYSICS. Alekseev, A. V.; Veselov, M. D.; Kuznetsov, V. S.; Lastochkin, Yu. A.; Mozalevskii, I. A.; Nikiforovskii, A. V.; Tarasov, B. I.; Frolov, A. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 66p. (In Russian). Dep.

The magnetic characteristics of the deflecting electric magnets Type CII-129, CII-12A1, CII-7A1 and quadrupole lenses Type 20K100A, 20K200A, 10K200A, that were designed for the beam transport system for the proton synchrotron of the Institute for High Energy Physics are presented. (auth)

32865 (KFKI-8/1969) ION OPTICS OF A HOMOGENEOUS ACCELERATOR TUBE WITH QUADRATIC ENTRANCE. Varga, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1969. 16p. Dep.

A method is described for improving the ion optical properties of an homogeneous accelerator tube by appropriately modifying its entrance aperture. It is shown that a low magnification can be ensured by simple means without pre-acceleration. (auth)

32866 (LNF-69/12) ELECTRON-POSITRON STORAGE RINGS: STATUS AND PRESENT LIMITATIONS. Amman, F.

(Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Feb. 28, 1969. 11p. (CONF-690308-4). Dep.

A review of the current status of electron and positron storage rings is presented. The experimental results on beam instabilities, their consequences on the design of a high current storage ring and the technological problems involved are discussed. (auth)

32867 ADVANCES IN THE DEVELOPMENT OF ELEMENTARY PARTICLE ACCELERATORS IN THE SOVIET UNION. Petrosyants, A. M.; Dzhelepov, V. P. pp 165-84 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968. (In Russian and English).

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

The development of accelerators in the Soviet Union is discussed. Emphasis is placed on the work of Maria Sklodowska-Curie in the finding of ways to accelerate charged particles, and the part she played in fostering international scientific cooporation. (J.F.P.)

32868 ELECTRON ANALOGUE OF RELATIVISTIC ANNULAR STRONG FOCUSING CYCLOTRON. Anosov, B. N.; Vasilenko, A. T.; Vorozhtsov, S. B.; (and others). At. Energy (USSR), 25: 539-41(Dec. 1968). (In Russian).

An electron analogue of a relativistic annular strong-focusing cyclotron with external diameter of over 2 m was constructed and used for studying dynamic processes in strong current proton accelerators with an internal beam current of several hundred milliampere. Characteristics of the accelerating system of the analog are high efficiency, high operational frequency and requires a low (1.5 to 3 kV) acceleration voltage. A description and operation procedure for the accelerator is given. (R.V.J.)

32869 CURRENTS AND COIL FORCES AS CONTOUR INTEGRALS IN TWO-DIMENSIONAL MAGNETIC FIELDS. Beth, Richard A. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 40: 2445-9(May 1969).

A general method is given for evaluating currents and coil forces in two-dimensional magnetic fields. When the field components H_Y and H_Y are known along a closed contour C in the field plane $Z = X + iY$ and define $H \equiv H_Y + iH_X$, the total current within C is $\oint_C H dZ/4\pi i$ and the total field force per unit length, $F \equiv F_Y + iF_X$, acting on all the currents within C is $-\oint_C H^2 dZ/8\pi$. As an example, the current and coil force are worked out for the uniform field magnet formed by intersecting parallel cylindrical conductors and compared with prior results. (auth)

32870 LOW ENERGY ELECTRON ACCELERATOR PRODUCING MEASURABLY SMALL FLUXES THROUGH UTILIZATION OF THE PHOTOELECTRIC EFFECT. McCullough, Edwin C. (Univ. of Maryland, College Park). Rev. Sci. Instrum., 40: 944-6(July 1969).

Described is an accelerator which utilizes the photoelectrons from an ultraviolet irradiation of a gold cathode to provide measurably small fluxes of low energy electrons. Operation of the accelerator is based upon the well established proportionality of photoelectric emissivity with intensity of irradiation such that accurately known small electronic fluxes are established through the use of filters of known transmissivities. With a stable light source and vacuum environment extraordinary flux stability is obtained with this accelerator. (auth)

32871 A 5 MeV ELECTRON LINEAR ACCELERATOR FOR CEA IN FRANCE. Irie, Koichi; Nemoto, Yoshiaki (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Lab. Rep., 9: 197-220(Oct. 1968).

A 5 MeV electron linear accelerator built for Commissariat a L'Energie Atomique of France is a compact and powerful x-ray generator. Length of the accelerator is below 2 meters, but more than 5 MW of microwave power at 2856 MHz can be supplied to the accelerator. Electron beams from 2 to 7 MeV can be obtained and x-ray beams of 1000 r/min can be obtained at 1 meter from target, when bombarded with 3 MeV electrons. For convenience in radiography, the accelerator can be rotated such that the direction of x radiation may be altered from −15 degrees to +15 degrees upwards and downwards in the vertical plane. Main performances are: maximum peak electron beam current is more than 500 mA, maximum average electron beam current is more than 800 μA, energy spread of the electron beam is less than 10%, and minimum electron beam diameter is about 3 mm. (auth) (NSA of Japan)

32872 BEAM TRANSPORT FOR A 300-MeV ELECTRON LINEAR ACCELERATOR OF TOHOKU UNIVERSITY. Gotoh, Masayuki; Akiba, Toshimitsu (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Lab. Rep., 9: 175-96 (Oct. 1968).

Three nondispersive deflecting systems and two spectrometers for the 300 MeV electron linear accelerator of Tohoku University were constructed and installed by Mitsubishi Electric Corporation. Nondispersive deflections of each system are observed and transformation coefficients are determined from data on beam profiles in the first system. These are $(x/x_0) = -1$ and $(x/x_0) = -0.015$, which are normalized by ρ of the central trajectory. It can be concluded that momentum dispersion of 2 mm/0.1% with maximum resolution 0.1% of the second system and maximum resolution 0.05% of the electron-spectrometer obtained from data on electron scattering experiments, are in good agreement with designed values. It can also be concluded that momentum dispersion of about 1 mm/0.1% with maximum resolution 0.15% of the first system and maximum resolution (momentum) 0.5% of the broad range spectrometer obtained from data on electron scattering experiments, fairly agree with designed values. (auth) (NSA of Japan)

32873 DESIGN FEATURE OF HIGH POWER RF SYSTEM OF ML-300 ELECTRON LINAC. PART 2. KLYSTRON PULSER. Abe, Hisayasu; Ikeda, Kazuo (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Lab. Rep., 9: 165-74(Oct. 1968).

A brief report is given of the construction, electrical characteristics, and circuit performance of the klystron pulsers of the ML-300 electron linac for Tohoku University. These pulsers are capable of supplying a pulse output of 250 kV, 270A at a duty ratio of 1.3×10^{-3} to the world's biggest pulse klystrons, TV-2014 of Thomson Varian Co. and PV-2014 of Mitsubishi Electric Corp. for their continuous operation at a maximum duty. Semiconductor technology was fully applied to the design of the pulsers to enable reliable and efficient operation of these high-power equipments. Since the inauguration of the ML-300 electron linac in 1967 they have been working successfully. (auth) (NSA of Japan)

32874 DESIGN FEATURE OF HIGH POWER RF SYSTEM OF ML-300 ELECTRON LINAC. PART 1. MICROWAVE SYSTEM. Toda, Tetsuo (Mitsubishi Electric Corp., Amagasaki, Japan).; Tachikawa, Seibei. Mitsubishi Denki Lab. Rep., 9: 149-64(Oct. 1968).

Herein are described composition, functions and characteristics of the microwave system of the 300 MeV electron linear accelerator built for Tohoku University. A waveguide system for transmitting S-band microwaves of the maximum peak power 10 MW is composed of components which are twenty one in kind and about four hundred and twenty pieces in number, its total length extending over 280 meters. In May 1967, construction works of this linac was completed, thereafter no fault has been experienced from microwave break-down. A coaxial system used for a low-level transmission line comprises thirteen kinds and about one hundred and thirty parts, most of which are of strip line type. The rf driver of high power pulsed klystron is composed of a cavity stabilized triode oscillator and two triode amplifiers. Besides, there are many accessory units necessary for the operation of the linac. (auth) (NSA of Japan)

32875 A 300 MeV ELECTRON LINEAR ACCELERATOR FOR TOHOKU UNIVERSITY. Toda, Tetsuo (Mitsubishi Electric Corp., Amagasaki, Japan); Irie, Koichi. Mitsubishi Denki Lab. Rep., 9: 117-48(Oct. 1968).

This paper describes the design, construction, and testing of the electron linear accelerator which has been constructed for Tohoku University. It is a traveling type, operating at 2856 MHz and utilized 5 klystron amplifiers, each delivering 20 MW of power in 4 μs pulses, repeated 50, 100, 150, 250, or 300 times per second. The klystrons are distributed along the length of 50 meters accelerator, feeding power into separate 20 accelerating structures, a buncher and a prebuncher. The electrons are injected at a voltage of 80 to 100 kV. Although the electron beam current obtained is low compared with design value because of beam blow-up, the other performances are quite satisfactory. Especially, a good energy spectrum of 1.8% is obtained. Maximum energy and maximum current obtained in high energy section are 300 MeV and 110 mA, respectively and those in high current section are 80 MeV and 350 mA, respectively. (auth) (NSA of Japan)

32876 RF SYSTEM FOR THE MITSUBISHI PROTON LINEAR ACCELERATOR. Fujita, Hyota (Mitsubishi Electric Corp., Amagasaki, Japan); Nagai, Akio. Mitsubishi Denki Lab. Rep., 9: 275-87(Oct. 1968).

The rf system for the 5 MeV Mitsubishi proton linac is reported. The rf high power source which operates by amplifying the output of a crystal-controlled master oscillator, operates at the frequency of 202.56 MHz, pulse duration time of 400 μs, pulse repetition rate of 20 pps. The maximum pulsed power is 1.4 MW. The final amplifier using a triode CFTH-515 is a grounded grid amplifier with tuned-coaxial circuits. The driver stages, driving the final ampli-

fier, use two TV tubes 4W 20,000A in cascade and output peak power is 350 kW. The rf power is transmitted to the linac tank through 8'' rigid coaxial lines and a 400 × 1150 mm wave guide, and terminated with a coupling loop. The tuning balls are installed in the linac tank so as to match its resonant frequency to the source frequency. This work has been performed under the auspices of the Ministry of International Trade and Industry. (auth) (NSA of Japan)

32877 FOCUSING SYSTEM FOR THE MITSUBISHI PROTON LINEAR ACCELERATOR. Fujita, Hyota (Mitsubishi Electric Corp., Amagasaki, Japan); Nagai, Akio. Mitsubishi Denki Lab. Rep., 9: 253-74(Oct. 1968).

For converging the beam in the proton linear accelerator, it is necessary to accomplish the high field gradient magnet as high as 7.4 kG/cm at first drift-tube in the N = 2 (NNSS) arrangement. A series of small and precise high gradient quadrupole magnets with new power supply system has been constructed. The field gradient is reached as high as 11.5 kG/cm with 22.5 mm aperture. The new power supply consists of only a.c. power source and S.C.R. switch without d.c. power supply, therefore it is very economical and compact. (auth) (NSA of Japan)

32878 DESIGN AND OPERATING CHARACTERISTICS OF A MICROTRON WITH 17 ORBITS. Kapitsa, S. P.; Melekhin, V. N.; Zakirov, B. S.; Zykin, L. M.; Luk'yanenko, E. A.; Tsipenyuk, Yu. M. (Inst. of Physical Problems, Moscow). Prib. Tekh. Eksp., No. 1, 13-18(Jan.-Feb. 1969). (In Russian).

The design parameters and operating characteristics of a microtron with 17 orbits are presented. With an energy of 10 MeV the pulse current is 50 mA and has an average power of 500 Watts. (tr-auth)

32879 THE SYNCHRONIZATION OF THE OPERATION OF THE COMPENSATOR WITH THE ACCELERATOR AND STABILIZATION OF THE OPERATING LEVEL OF THE COMPENSATING MAGNETIC FIELD. Tkachenko, V. D.; Shenderovich, A. M. (Physical-Technical Inst., Kharkov). Prib. Tekh. Eksp., No. 1, 18-20(Jan.-Feb. 1969). (In Russian).

A system was described for synchronization of the operation of a storage ring with an electron linear accelerator for injecting electron beams into the storage ring by means of bending magnets. A formula for evaluating the efficiency of the system is included. (C.E.S.)

32880 STUDY OF AN AXIALLY SYMMETRICAL BEAM OF IONS. Teplyakov, V. A.; Derbilov, V. I. Prib. Tekh. Eksp., No. 1, 21-4(Jan.-Feb. 1969). (In Russian).

It was shown that by means of selection of the expansion configuration and the electrodes of the ion source, it is possible to obtain a beam closely associated to parameters being described by theory. It was also shown that the cross scattering rates of ions on the plasma boundary of the source does not depend on the degree of expansion of the plasma. The brilliance of the source by this method is greater than the less emitting plasma surface. The minimum dimension of the surface is prescribed. The brilliance of a duoplasmatron was increased utilizing this method. (tr-auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 32926, 32948, 33102, 33103, and 33111.

32881 (ANL-7519) MOMENTS OF FIRST-PASSAGE DISTRIBUTIONS IN SLAB GEOMETRY. Brockwell, P. J.; Landwehr, J. M. (Argonne National Lab., Ill.). Dec. 1968. Contract W-31-109-eng-38. 54p. Dep. CFSTI.

A transport model is formulated to obtain the moments of first-passage distributions in slab geometry. General stochastic theory is followed and a discrete approximation method is used. (J.W.R.)

32882 (BNL-tr-272) WAVE DIFFRACTION IN THE PRESENCE OF SOME REFRACTIVE INDICES. Baryshevskii, V. G.; Korennaya, L. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P4-4202. 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 23606.

32883 (NUS-TM-S-49) PHOTON AND NEUTRON EMISSION FROM PuO_2 PARTICLES AS A FUNCTION OF PARTICLE SIZE. Denham, Roy S. (NUS Corp., Washington, D. C.). Mar. 10, 1967. Contract 48-4310. 16p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Information is presented on photon and neutron emission in $^{238}PuO_2$ fuel utilized for thermoelectric power systems. The photon and neutron flux at the surface of fuel particles as a function of particle size from 5μ to 250μ diameter was calculated and is presented graphically. (auth)

32884 (NYO-3822-9) OPERATION OF A 4 mA DYNAMITRON AS A MONOENERGETIC NEUTRON SOURCE. Report No. 1139. Haberl, A. W.; Taylor, A. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Mar. 11, 1969. Contract AT(30-1)-3822. 13p. Dep. CFSTI.

The Cornell Dynamitron is being used as a source of monoenergetic neutrons in the range 30–500 keV, with fluxes up to 10^9 n/sr/s. Problems of generating and handling the 2 MeV, 4 mA beam are discussed. Analyzing magnet slit feedback is essential for accurate control of neutron energy. Contrary to other published data for these machines, up to 3% drift in the energy is observed when it is controlled by the voltage feedback system. Discrepancies between this and previously published data are discussed. (auth)

32885 (ORNL-TM-2508) USE OF KERNELS IN STUDYING NEUTRON TRANSPORT PROBLEMS. Cramer, S. N.; Cain, V. R.; Coveyou, R. R.; Stevens, P. N.; Straker, E. A. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 161p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

In the study of neutron transport in an air medium by the Monte Carlo technique, excessive computer time is required in following the neutrons through the keV and eV energy ranges due to the small energy loss per collision. At these energies, neutron scattering in air is elastic and isotropic in the center-of-mass system, the cross sections are slowly varying in energy, and absorptions are negligible. It is these conditions which make an analytic solution possible but cause a Monte Carlo solution to become time consuming. An analytic time-, spatial-, and energy-dependent kernel is derived for an infinite homogeneous medium with constant cross sections assuming continuous slowing down of neutrons. This kernel is coupled with a Monte Carlo solution creating an estimator from collisions in the keV energy range to lower energies. In addition to the analytic development, a general investigation of transport model coupling techniques is performed by solving the Boltzmann transport equation for two regions of phase space. It is shown that the coupling of the Monte Carlo and analytic models is a special case of the general coupling approach. Results from the analytic model and its combination with the Monte Carlo solution give excellent agreement with results from a complete Monte Carlo solution in the entire energy range. Considerable machine time is also saved in obtaining answers having comparable statistical error with the complete Monte Carlo solution. (auth)

32886 (WAPD-TM-768) PUN-1: A FORTRAN-IV PROGRAM FOR THE EVALUATION OF UNRESOLVED RESONANCE INTEGRALS AND RELATED MULTIGROUP CROSS SECTIONS (LWBR DEVELOPMENT PROGRAM). Steen, N. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1969. Contract AT(11-1)-Gen-14. 38p. Dep. CFSTI.

PUN-1 evaluates the Doppler-broadened, infinitely dilute, and self-shielded radiative-capture resonance integrals and related multi-group cross sections from unresolved resonances. The unresolved distributions may have resonances with angular-momentum quantum numbers $\chi = 0, 1, 2, 3,$ or 4. The effect of statistical fluctuation of the reduced neutron width, Γ_{n0} is included for each χ, J state using a chi-square distribution with from 1 to 8 degrees of freedom. The degree of freedom for each χ, J State is assigned by the requestor. The capability of examining only levels for which Γ_{n0} is less than some input fraction, b, of the average value for the spin state is included. An improved escape probability is used in place of the rational approximation for rod lattices in either a hexagonal or square array. For these systems, the Dancoff shadowing correction may be computed internally, with a correction included for the effect of fuel clad. For other configurations, the shadowing correction is input and the rational escape probability is used. The energy-flux weighting is permitted to be an arbitrary function of energy, as well as the classic 1/E dependence. (auth)

32887 (WAPD-TM-856) AN APPLICATION OF LOMMEL'S FUNCTIONS TO NEUTRON TRANSPORT IN TIME-DEPENDENT P_1 THEORY. Burger, J. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1969. Contract AT(11-1)-Gen-14. 10p. Dep. CFSTI.

The very fundamental problem of neutron transport in a semi-infinite moderating slab is solved in a P_1 approximation, utilizing a fairly recent development in mathematics—Lommel functions of two purely imaginary arguments. One strength of this method is its consistency—the boundary conditions represent the exact transport boundary conditions in a P_1 approximation. Another strength of this method is its simplicity because the Lommel functions are conveniently tabulated. The P_1 approach represents the most sophisticated attack to date at the problem of graphing the space-time dependence of the flux. (auth)

32888 MEASUREMENT OF THE NEUTRON DOSE FROM A PuBe SOURCE. Shader, R. A.; Eldridge, H. B. (Univ. of Wyoming, Laramie). Health Phys., 16: 765-9(June 1969).

The measurements described were made in connection with the use of a PuBe neutron source in studies on nuclear structure employing a neutron time-of-flight system. In order to obtain an estimate of the biological dose due to neutrons the energy spectrum must first be determined, since the factor which converts neutron flux density to dose depends on neutron energy. In the many available measurements of the energy spectrum of neutrons from PuBe sources, the effects of ^{241}Pu contamination, ^{239}Pu fission, and various neutron interactions with Be were neglected. These effects, which tend to modify the neutron energy spectrum, depend on the size, method of construction, and age of the neutron source, and considerable variation in the energy spectrum may be found for different sources and for a given source at different times. In view of this possible variation the fast neutron spectrum from the source used in the neutron time-of-flight experiments was measured in a similar geometrical arrangement, so as to arrive at an estimate of the fast neutron dose that could be expected when working on the experiment. The method employed is described, and the results are discussed. It was concluded that calibration of neutron survey meters using such sources should be treated with caution. (auth) (UK)

32889 COMPARISON BETWEEN MEASURED AND CALCULATED STATIONARY THERMAL NEUTRON SPECTRA IN HETEROGENEOUS SYSTEMS. Caspers, Leopold Maria. Delft, Netherlands, Technische Hogeschool, 1968. 100p.

Thesis.

A program was undertaken to experimentally verify models and cross sections used in calculations of stationary space-dependent thermal neutron spectra. Detailed knowledge of thermal spectra is particularly important for reactor cell applications. In connection with the program a neutron time-of-flight spectrometer was designed, techniques were developed for the activation of foils to supplement time-of-flight measurements, and computer programs were developed for calculating space-dependent spectra and scattering kernels. Measurements were made of infinite-medium spectra, spectra in slabs and mock-up cells, and leakage spectra. (J.W.R.)

32890 SUPERBOOSTER. Constantine, G. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Energy, 38-47 (Mar.-Apr. 1969).

The "Superbooster" is a design for a source of thermal and low epithermal neutrons. Electrons with an energy of 150 MeV, generated by a linear accelerator, are fed to a plutonium-fueled

sodium-cooled fast subcritical assembly which has a multiplication factor of 200. The neutrons emerging are moderated by water. An effective pulse width of 25 μs at up to 200 pulses per second may be obtained. The physics aspects of the design are discussed and some of the engineering problems are outlined. (UK)

32891 INVARIANT IMBEDDING AND CASE EIGENFUNCTIONS. Pahor, S.; Zweifel, P. F. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.), 10: 581-9(Apr. 1969).

A new approach to the solution of transport problems, based on the ideas introduced into transport theory by Ambarzumian, Chandrasekhar, and Case, is discussed. To simplify the discussion, the restriction to plane geometry and one-speed isotropic scattering is made. However, the method can be applied in any geometry with any scattering model, so long as a complete set of infinite-medium eigenfunctions is known. First, the solution for the surface distributions is sought. (In a number of applications this is all that is required.) By using the infinite-medium eigenfunctions, a system of singular integral equations together with the uniqueness conditions is derived for the surface distributions in a simple and straight-forward way. This system is the basis of the theory. It can be reduced to a system of Fredholm integral equations or to a system of nonlinear integral equations, suitable for numerical computations. Once the surface distributions are known, the complete solution can be found by quadrature by using the full-range completeness and orthogonality properties of the infinite-medium eigenfunctions. The method is compared with the standard methods of invariant embedding, singular eigenfunctions, and a new procedure recently developed by Case. (auth)

32892 MODERATING ABILITY OF NEUTRON INELASTIC SCATTERERS. Kozhevnikov, D. A.; Chekanova, S. S. At. Energ. (USSR), 26: 334-7(Apr. 1969). (In Russian).

The moderating ability of various elements was calculated with the indicatrix of neutron inelastic scattering on the basis of the statistical nuclear model. The elements of interest for some applied problems of neutron transport theory were studied. The nuclear temperatures were calculated in the Fermi-gas model accounting for pair correlations. The microscopical moderating ability $s^{in}(\epsilon)$ of elements with mass number A < 30 exceeds the moderating ability of hydrogen $s_H(\epsilon)$ or is comparable with it; $s^{in}(\epsilon)$ of elements with 30 < A < 130 values is 3 to 4 times as large as $s_H(\epsilon)$; $s^{in}(\epsilon)$ of elements with A > 130 is 6 to 8 times as large as $s_H(\epsilon)$ (if $\epsilon > 5$ MeV). (auth)

Nuclear Properties and Reactions, A≤5

Refer also to abstract 32900.

32893 (ORNL-4404) ELECTRONUCLEAR DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1968. Howard, F. T. (ed.) (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 166p. Dep. CFSTI;

Three categories of experimental nuclear physics studies are described: efforts in the field of nuclear spectroscopy with direct reactions, the characterization of nuclear forces, and the program of nuclear spectroscopy with decay scheme techniques. Nearly 30 experimental projects in a wide range of disciplines are briefly summarized. Theoretical studies include the investigation of the effects of inelastic scattering, or "core excitation," during deuteron stripping reactions and of the exchange, or knock-on, contributions in the microscopic theory of the inelastic scattering of nucleons. Several improvements were made in ORIC. A new ion-source positioning mechanism markedly reduces the time required to obtain a good beam on target; the rf regulator was modified to give a good response over a wider band; and perhaps of most significance, usable extracted beams of heavy ions in the 3+, 4+, and 5+ states are now available. Accelerator development was chiefly concerned with studies of various methods of accelerating very heavy ions to energies high enough to produce nuclear reaction in heavy-element targets. A system now under study would use a tandem generator to inject stripped ions into a sector magnet cyclotron to accelerate heavy ions to 7.5 MeV/amu. Fabrication and assembly of the Separated Orbit Cyclotron Experiment, the 4-MeV SOCE, was nearly completed. (auth)

32894 PHOTODISINTEGRATION OF ULTRAHIGH-ENERGY COSMIC RAYS BY THE UNIVERSAL RADIATION FIELD. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 180: 1264-6(Apr. 25, 1969).

A detailed calculation was carried out to determine the effectiveness of the universal radiation field in disintegrating ultrahigh-energy cosmic-ray nuclei. It is concluded that this process cannot lead to a pure-proton interpretation of the air-shower observations above 10^9 GeV. Photodisintegration by the universal radiation is unimportant on time scales of 10^{10} yr or less for helium nuclei below 10^{10} GeV and for iron nuclei below 10^{11}-GeV total energy. Photodisintegration by dilute starlight photons in intergalactic space is unimportant on time scales of 10^{10} yr or less at all energies. (auth)

32895 ELASTIC SCATTERING OF PROTONS BY DEUTERIUM. Wilson, A. S.; Taylor, M. C. Legg, J. C.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys., A130: 624-34(1969).

Proton-deuteron elastic scattering was investigated with a gas target. Excitation curves were taken at 45.28, 90.26, and 118.92° cm for lab proton energies from 4.5 to 11.5 MeV. Angular distributions were taken at 4.45, 5.45, 6.50, 7.46, 8.47, 9.47, 10.47, and 11.47 MeV from 30 to 140° cm. Differential cross sections were measured with an absolute error of less than ±3%. The scattering data were compared with predictions derived from the scattering amplitudes of Aaron, Amado and Yam. No evidence for the existence of ^{3}He excited states was found in this energy range. (auth)

32896 NUCLEON–NUCLEON FINAL-STATE INTERACTIONS IN THE REACTIONS ^{3}He(p,d)2p, ^{4}He(p,t)2p, AND ^{4}He(p,^{3}He)pn. Harbison, S. A. (London Univ.); Griffiths, R. J.; Kingston, F. G.; Johnston, A. R.; Squier, G. T. A. Nucl. Phys., A130: 513-26(1969).

The energy spectra of deuterons, tritons and ^{3}He particles from the reactions ^{3}He(p,d)2p, ^{4}He(p,t)2p and ^{4}He(p,^{3}He)pn were measured at angles between 6 and 60° lab. The ^{3}He(p,d)2p reaction was studied at both 30.5 and 49.5 MeV incident proton energies, while the other two reactions were studied at 49.5 MeV only. The energy spectra are compared with calculations based on the Watson–Migdal model of final-state interactions. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 32605, 32624, and 32893.

32897 (ANU-P-444) OPTICAL-MODEL FOR LOW ENERGY HELIONS SCATTERED FROM ^{16}O NUCLEI. Nurzynski, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 19p. Dep.

Averaged angular distributions of elastically scattered ^{3}He particles from ^{16}O nuclei, obtained from measurements carried out at six incident energies between 9.802 and 10.720 MeV, were analyzed using six or four parameters in the optical-model potentials with volume or surface absorption. The existence of discrete radius ambiguities for the real part of six-parameter potentials is demonstrated. Four-parameter potentials were found to be less ambiguous and produced as good fits as those obtained with the more complex six-parameter potentials. (auth) (Australia)

32898 (ANU-P-449) ZERO DEGREE NEUTRON YIELD FROM THE ^{7}Li(p,n)^{7}Be REACTION NEAR 2.2 MeV. Lefevre, H. W.; Din, G. U. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 20p. Dep.

A discrepancy between calculated and measured neutron spectra from this reaction is discussed. Results from a relative yield curve measurement with a long counter are compared with existing data. (auth) (Australia)

32899 (ANU-P-450) GAMMA RADIATION FROM THE ^{19}F(p,αγ)^{16}O REACTION BETWEEN 1.9 MeV AND 4.16 MeV. Osman, C. H.; Rosalky, D. M.; Baugh, D. J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 22p. Dep.

The ^{19}F(p,αγ)^{16}O reaction was studied. Total cross sections for transitions from the 6.13-, 6.92-, 7.12-, and 8.88-MeV states in ^{16}O were measured between 1.9 and 4.16 MeV in 20-keV steps. Line shape analysis of Doppler-broadened Ge(Li) γ-ray lines was employed. (auth) (Australia)

32900 (ANU-P-453) THE β-DECAY OF ^{8}B AND 2^+ STATES OF ^{8}Be. Clark, G. J.; Treacy, P. B.; Tucker, S. N. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 16p. Dep.

The beta decay of ^{8}B was investigated by measuring the energy distribution of the α particles from subsequent break-up of ^{8}Be. The data were analyzed, in conjunction with data from α–α elastic scattering, in a three-level R-matrix formalism. Consistent fits are obtained for channel radius (6.0 ± 0.5) fm, and the existence of a broad 2^+ state of ^{8}Be near 12.0 MeV, of width 14 MeV, is confirmed. (auth) (Australia)

32901 (PUC-937-350) P,D AND P,T REACTIONS IN THE 2S-1D SHELL. Haight, Robert C. (Princeton Univ., N. J. Palmer Physical Lab.). Jan. 1969. Contract AT(30-1)-937. 174p. Dep. CFSTI.

Thesis.

The p,d and p,t reactions on several 2s-1d shell nuclei were studied with 17.5-MeV protons from the Princeton 28-in. F.M. cyclotron. The p,d reaction on the following targets was investigated: ^{19}F, ^{23}Na, ^{25}Mg, ^{26}Mg, ^{27}Al, ^{29}Si, ^{30}Si, and ^{31}P. The p,t reaction was studied with targets of ^{19}F, ^{26}Mg, and ^{31}P. Differential cross sections for each reaction were measured at many angles. The angular distributions for single neutron transfer were compared with D.W.B.A. calculations to give spectroscopic information. The validity of this analysis is discussed. Positive parity assignments are made for the 2.36-MeV state of ^{26}Al and for the 2.73- and 2.94-MeV states of ^{30}P. Negative parity assignments are confirmed for several states of ^{18}F and ^{22}Na, and those with significant 1-p hole strengths are identified. The spectroscopic factors for single neutron pickup are compared with the predictions of shell-model calculations, of the rotational model, and of the unified model. The rotational (strong-coupling) model accounts well for the spectroscopic factors extracted from the ^{25}Mg(p,d)^{24}Mg data. This model also accounts for many of the spectroscopic factors in the ^{23}Na(p,d)^{22}Na, ^{26}Mg(p,d)^{25}Mg, ^{27}Al(p,d)^{26}Al, and ^{29}Si(p,d)^{28}Si reactions. On the other hand, the spectroscopic factors for s-wave neutron pickup in the ^{19}F(p,d)^{18}F reaction are not accounted for by the strong-coupling model; a shell model calculation does account for them, however. The ^{30}Si(p,d)^{29}Si and ^{31}P(p,d)^{30}P cross sections have not yet been explained by any of these models. (auth)

32902 (RLO-1925-20) NUCLEAR PHYSICS RESEARCH. Progress Report for the Year Ending May 31, 1969. (Oregon Univ., Eugene. Dept. of Physics). Contract AT(45-1)-1925. 79p. Dep. CFSTI.

BERYLLIUM-9—deuteron reactions (α,γ) at 1.4 MeV, γ spectra for, (E)
CARBON-12—deuteron reactions (α,n) at 0.7 to 4 MeV cross section for, (E)
—deuteron reactions (d,p) at 3.3 to 3.7 MeV, analysis of excitation functions using DWBA and compound nucleus amplitudes, (E/T)
NEUTRON SPECTROMETERS—photomultiplier design for time-of-flight
OXYGEN-16—deuteron reactions (d,n) at 2 to 4 MeV, cross section for, (E)
PHOTOMULTIPLIER TUBES—design for neutron time-of-flight spectrometer
PULSE DISCRIMINATORS—design and performance of neutron-gamma
SULFUR-32—energy levels from phosphorus-31(p,γ) reactions, lifetimes and spin assignments for, (E)

32903 SHELL-MODEL CALCULATIONS WITH WOODS-SAXON WAVE FUNCTIONS IN ^{16}O AND ^{42}Ca. Kanestroem, I.; Koren, H. (Univ., Oslo). Nucl. Phys., A130: 527-40(1969).

Two-particle states of ^{16}O and ^{42}Ca are calculated within the shell model. The nuclear cores are represented by Woods-Saxon potentials, and for the residual interaction, central forces of Yukawa and Gaussian types are used. The wave functions for the low-lying states except for the 0^+_2 and 2^+_2 states in ^{42}Ca are obtained, and the calculated energy spectra are in good agreement with experiments. Also E2 transitions are calculated and compared with experimental results. (auth)

32904 MAGNETIC EXCITATIONS IN ^{12}C BY INELASTIC ELECTRON SCATTERING AT 180°. Vanpraet, G. J.; Kossanyi, P. (Stanford Univ., Calif.). Z. Phys., 222: 455-61(1969).

Nuclear excitations in ^{12}C were investigated by inelastic scattering of 50, 65, and 70 MeV primary electrons at 180°. Cross sections were measured of the inelastic peaks observed between 15 and 20 MeV. The behavior of the corresponding transverse form factor as a function of momentum transfer is compared with theoretical predictions and other experimental ^{12}C(e,e′) results. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 32893, and 32901–32903.

32905 (AAEC/E-198) RESONANCE PARAMETERS FOR MEASURED keV NEUTRON CAPTURE CROSS SECTIONS. Musgrove, A. R. de L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1969. 39p. Dep.

All available neutron capture cross sections in the keV region (~5 to 100 keV) were fitted with resonance parameters. Capture cross sections for nuclides with reasonably well known average s-wave parameters, but no measured cross section, were calculated and tabulated using p- and d-wave strength functions interpolated between fitted values. Several of these nuclides are of interest in the theory of slow nucleosynthesis of heavy elements in stars, and the product of cosmic abundance (due to the s-process) and capture cross section at 30 keV was plotted versus mass number. (auth)

32906 (ANU-P-421) ENERGY LEVELS IN ^{57,59,61}Co FROM THE ^{60,62,64}Ni(p,α) REACTIONS. Coop, K. L.; Graham, I. G.; Poate, J. M.; Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 17p. Dep.

Enriched targets of ^{60,62,64}Ni were bombarded with protons of energies ranging from 9.5 to 10.5 MeV. Alpha particles populating levels in ^{57,59,61}Co were analyzed magnetically using a Buechner broad-range spectrograph with photographic-plate detection. Several new energy levels were found in ^{61}Co including the third excited state which has been located at 1.287 MeV. Some nuclear systematics of the odd-mass cobalt isotopes are discussed. (auth) (Australia)

32907 (ANU-P-423) RESONANCES OF THE ^{26}Mg(p,γ) REACTION BETWEEN 660 AND 1000 keV. Huang, F. C. P.; Ophel, T. R. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 28p. Dep.

Gamma-ray spectra of the 661, 719, 809, 839, 954 and 982 resonances of the ^{26}Mg(p,γ) reaction were obtained with a Ge(Li) detector. The decay schemes of the resonances and angular distribution measurements enabled spin assignments to be made for the 3.678 ($\frac{1}{2}$), 5.552 ($\frac{1}{2}$), 5.751 ($\frac{1}{2}$) and 5.828 ($\frac{3}{2}$) MeV levels. (auth) (Australia)

32908 (ANU-P-426) REACTION ^{23}Na(p,p) IN THE RANGE 8.0 TO 12.0 MeV. I. ANALYSIS OF AVERAGE ELASTIC CROSS SECTIONS. Hellstroem, J.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 25p. Dep.

Absolute differential cross sections were measured for the elastic scattering of protons from ^{23}Na. Excitation functions were measured in 20 keV steps for incident proton energies from 8.0 to 12.0 MeV and at 23 different angles. Average angular distributions every 0.5 MeV were obtained from smooth fits to the excitation functions and these were analyzed using the optical Model and Hauser-Feshbach theories. The variations with energy of the optical model potentials, the compound nucleus reduction factor and the amount of compound nucleus and direct reaction cross sections were investigated. There is some evidence for the presence of intermediate structure in the compound nucleus ^{24}Mg. (auth)

32909 (ANU-P-442) COMPOUND AND DIRECT PROCESSES IN PROTON ELASTIC SCATTERING FROM ^{31}P AND ^{62}Ni. Dallimore, P. J.; Davidson, W. F.; Hellstroem, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 37p. Dep.

Absolute differential cross sections were measured for the elastic scattering of protons from ^{31}P and from ^{62}Ni. For ^{31}P the measurements were taken in 10 keV steps from 8.00 to 8.20 MeV and at 27 angles. For ^{62}Ni six angular distributions were measured between 8.00 and 8.05 MeV. The averaged angular distributions were analyzed using the optical model and Hauser-Feshbach theories. The effect of reducing the Hauser-Feshbach contribution to allow for direct interaction competition was investigated. (auth)

32910 PRODUCTION OF HYPERNUCLEI FROM THE INTERACTIONS OF 10.1 GeV/c K$^-$-MESONS WITH EMULSION NUCLEI. Coremans, G. (Univ. Libre, Brussels); Cantwell, T.; Thompson, A.; Esmael, F.; Stanley, D.; Pniewski, T. Nuovo Cim., 61A: 525-31(June 1, 1969).

Some experimental data concerning the production of hypernuclei from the interactions of 10.1 GeV/c momentum K$^-$-mesons with emulsion nuclei are presented. The production frequency of observed hypernuclei is found to be (1.19 ± 0.06)%. The production characteristics are compared with those at lower K$^-$ momenta. (auth)

32911 THE DECAY OF ^{75}Se. Raeside, D. E.; Ludington, M. A.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A130: 677-86(1969).

The gamma-ray spectrum associated with the electron-capture decay of ^{75}Se was studied with Ge(Li) spectrometers. Coincidence spectra were taken with a Ge(Li)-Ge(Li) combination. The data do not support a recent report of several new gamma rays in the decay of ^{75}Se. Gamma-gamma angular correlation experiments were performed with a NaI(Tl)-Ge(Li) combination. The value obtained

for δ(280 keV) is an excellent agreement with one recently reported value but in poor agreement with another. The ratio P_K/P_{tot} for the electron capture branch to the 401 keV level of ^{75}As was determined, and the result agrees with previous experimental determinations. (auth)

32912 TRANSITION POTENTIALS FOR (d,p) REACTIONS. Smith, William R. (Nuclear Physics Lab., Oxford). Contract F61052.67.C.0104. Nucl. Phys., A130: 657-71(1969).

Finite-range calculations are carried out in the distorted wave Born approximation to obtain the ^{28}Si(d,p)^{29}Si and ^{90}Zr(d,p)^{91}Zr stripping differential cross sections at a number of different bombarding energies. The transition interaction responsible for the A(d,p)B reaction is assumed to be $V_{pn} + V_{pA} - V_{pB}$ rather than just the proton-neutron interaction V_{pn} alone. Various assumptions are made about the forms of this interaction. The exact calculations are compared with second order approximate finite-range calculations employing a Hulthén form for V_{pn}. (auth)

32913 WIDTH-FLUCTUATION EFFECTS IN ANGULAR CORRELATION IN INELASTIC NUCLEON SCATTERING. Mathur, Suresh C.; Donati, Donald R. (Lowell Tech. Inst., Mass.). Nucl. Phys., A130: 595-603(1969).

The effects of level-width fluctuations on the nucleon-gamma angular correlations and double-differential cross sections were studied on the basis of Moldauer's formulation. Computational procedures for pursuing the width-fluctuation studies on a routine basis for reactions following the compound nucleus mechanism were developed. The width-fluctuation effects in (n,n'γ) reactions with ^{24}Mg and ^{56}Fe were calculated. These calculations indicate that the inclusion of width-fluctuation considerations significantly reduces the double differential cross sections compared to those made on the basis of Hauser–Feshbach theory. However, as expected, the shape of the angular correlation function is not significantly altered by the width-fluctuation corrections. (auth)

32914 THE DECAY OF ^{73}Se. Murray, G. (Univ. of Manchester, Eng.); White, W. J. K.; Willmott, J. C.; Entwistle, R. F. Nucl. Phys., A130: 563-76(1969).

The energies and relative intensities of the γ-rays following the radioactive decay of 7.1 h ^{73}Se and 42 min ^{73m}Se produced by the ^{70}Ge(α,n) reaction were measured using Ge(Li) detectors. The excitation functions of the 11 most prominent γ-rays following the ^{73}Se decays were studied. A level scheme for ^{73}As is proposed and compared with those of ^{75}As and ^{77}As. (auth)

32915 THE MAGNETIC MOMENT OF THE 344 keV LEVEL OF ^{152}Gd. Zmora, H.; Blau, M.; Ofer, S. (Hebrew Univ., Jerusalem). Nucl. Phys., A130: 541-4(1969).

The magnetic moment of the 344 keV level of ^{152}Gd was determined from measurements of the rotations of the angular correlations of γ-γ cascades involving this level in the magnetic hyperfine field of Gd metal. The value found for $g\tau$ is $(2.43 \pm 0.22) \cdot 10^{-11}$ sec. Taking $\tau = (7.6 \pm 1.3) \cdot 10^{-11}$ sec, a value of 0.32 ± 0.06 was derived for the gyromagnetic ratio of this level. (auth)

32916 HYPERFINE STRUCTURE AND g_J VALUE OF THE $^4F_{\frac{9}{2}}$ AND $^4P_{\frac{5}{2}}$ LEVELS OF ^{63}Cu AND ^{65}Cu. Blachman, Arthur G.; Landman, Donald A.; Lurio, Allen (Columbia Univ., New York). Phys. Rev., 181: 70-5(May 5, 1969).

The hyperfine structure of the $(3d^94s4p)$ $^4F_{\frac{9}{2}}$ and $^4P_{\frac{5}{2}}$ metastable levels in ^{63}Cu and ^{65}Cu were measured by the atomic-beam magnetic-resonance method. From the Zeeman effect of the hfs, $g_J(^4F_{\frac{9}{2}}) = 1.3340(2)$ and $g_J(^4P_{\frac{5}{2}}) = 1.600(2)$ were found. By making use of the ratio $^{63}A/^{65}A$ in the $^2S_{\frac{1}{2}}$, the $^4F_{\frac{9}{2}}$, and the $^4P_{\frac{5}{2}}$ states, $^{63}g_I/^{65}g_I = 0.933524(5)$ and that $^{63}\Delta^{65}(^2S_{\frac{1}{2}}) = 0.000048(5)$. Also it was found that $^{63}Q/^{65}Q = 1.08054(14)$. (auth)

32917 SEARCH FOR ^{74m}As. Weirauch, W.; Schmidt-Ott, W.-D. (Univ., Goettingen, Ger.). Z. Phys., 222: 474-8(1969). (In German).

An activity with the decay properties $T_{\frac{1}{2}} = (8.0 \pm 0.3)$ sec and $E_\gamma = (283 \pm 5)$ keV was produced by Schardt and Goodman by proton irradiation of thin layers of evaporated ^{72}Ge and ^{74}Ge on thick gold backings. This activity was interpreted as the new isomer ^{74m}As. In the present experiment a search for ^{74m}As was carried out using the reactions ^{75}As(n,2n), ^{71}Ga(α,n) and ^{74}Ge(d,2n). ^{74m}As could not be detected. Upper limits for the reaction cross sections were determined. It is discussed that the reported properties of ^{74m}As resemble the known properties of ^{197m}Au. (auth)

32918 E2/M1 MIXING RATIOS OF 2^+–2^+ TRANSITIONS IN ^{58}Fe, ^{74}Ge, AND ^{186}Os. Schoetzig, U.; Schrader, H.; Stippler, R.; Muennich, F. (Technische Univ., Brunswick). Z. Phys., 222: 479-90(1969).

E2/M1 mixing ratios of 2^+-2^+-transitions in ^{58}Fe, ^{74}Ge, and ^{186}Os were determined by measuring the angular correlation of the 2-2-0 $\gamma\gamma$-cascades in these nuclei. The following values were obtained: ^{58}Fe(863 keV): $\delta = +1.10 \pm 0.20$; ^{74}Ge(609 keV): $\delta = -2.9 \pm 0.8$ and ^{186}Os(630 keV): $\delta = -13^{+\infty}_{-3}$. These results are compared with theoretical predictions. (auth)

32919 SCATTERING OF ALPHA-PARTICLES BY ^{55}Mn. Gabrielli, L.; Harvey, B. G.; Hendrie, D. L.; Mahoney, J.; Meriwether, J. R.; Valentin, J. (Univ. of California, Berkeley). Nuovo Cim., 61B: 177-84(May 11, 1969).

The elastic and inelastic scatterings of 50-MeV alpha particles by ^{55}Mn were measured. The angular distributions of the scattered alphas from several excited levels were analyzed by means of the distorted-wave Born approximation. Transition strengths were determined for most of the levels observed. The energy resolution was sufficiently good to permit separation of the first excited state (0.126 MeV) from the elastic peak. Two single states previously observed in alpha scattering were each resolved into two states (2.25 and 2.37 MeV, probable transition l = 2; 4.27 and 4.39 MeV, probable transition l = 3). (auth)

32920 MUON PARTIAL CAPTURE RATES USING ^{28}Si, ^{32}S, ^{40}Ca AS TARGETS AND Ge-Li AS DETECTOR. Pratt, T. A. E. C. (Carnegie-Mellon Univ., Pittsburgh). Nuovo Cim., 61B: 119-30(May 11, 1969).

Certain nuclei have been observed to be produced after muon capture in a target material. These daughter nuclei were identified through decay of their excited states. The gammas so emitted were detected using germanium-lithium drifted detectors. Partial capture rates are quoted for captures to these excited states. Discussion involves the following nuclei produced from their respective target nucleus: ^{28}Al, ^{27}Al, ^{27}Mg and ^{26}Mg from ^{28}Si as target; ^{32}P, ^{31}P, ^{30}P, ^{31}Si, and ^{30}Si from ^{32}S as target; ^{40}K, ^{39}K, ^{39}Ar and ^{38}Ar from ^{40}Ca as target. (auth)

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Refer also to abstracts 31478, 32893, 32905, 32910, 32912, 32918, 32945, and 32970.

32921 (AE-352) DECAY OF ^{191}Os. Malmskog, S. G.; Baecklin, A. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Mar. 1969. 24p. Dep.

Gamma ray and conversion electron energies and intensities for transitions in ^{191}Ir were measured in the decay of ^{191}Os using a Ge(Li) detector and a double focusing beta spectrometer. The following energies (in keV) and transition multipolarities were found: 41.92 ± 0.02 (E3), 47.05 ± 0.03 (E2), 82.46 ± 0.04 (56 percent M1 + 44 percent E2) and 129.52 ± 0.02 (88 percent M1 + 12 percent E2). From a delayed coincidence measurement the half-life of the 129.52 keV level in ^{191}Ir was found to be $(1.26 \pm 0.11) \times 10^{-10}$ sec. (auth) (SWED)

32922 (AERE-R-6056) CALCULATED INDEPENDENT YIELDS IN THERMAL NEUTRON FISSION OF ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu, AND IN FISSION OF ^{232}Th, ^{238}U AND ^{240}Pu. Crouch, E. A. C. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 24p. Dep. CFSTI. UK 4s. 0d.

The independent yields of fission products were calculated for the thermal neutron fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu and for the fast reactor fission of ^{232}Th, ^{238}U, and ^{240}Pu by a method derived from that of Wahl et al. (auth) (UK)

32923 (BNL-tr-265) CROSS SECTION FOR FISSION OF ^{238}Pu BY FAST NEUTRONS. Ermagambetov, S. B.; Smirenkin, G. N. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 25: 527-9(1968). 9p. Dep. CFSTI.

Cross sections were measured for the fission of ^{238}Pu by 0.5- to 17-MeV neutrons. (J.W.R.)

32924 (BNL-tr-266) AVERAGE NUMBER OF PROMPT NEUTRONS IN SPONTANEOUS FISSION OF ^{242}Pu. Prokhorova, L. I.; Smirenkin, G. N.; Turchin, Yu. M. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 25: 530-1(1968). 3p. Dep. CFSTI.

The average number of prompt neutrons per spontaneous fission of ^{242}Pu was measured relative to ^{244}Cm using ^{3}He counters. (J.W.R.)

32925 (CONF-681032–, pp 23-130) NUCLEAR AND PHYSICAL PROPERTIES OF ^{252}Cf. Prince, A. (Brookhaven National Lab., Upton, N. Y.).

The nuclear and physical properties of ^{252}Cf are reviewed. The alpha decay scheme, spontaneous and neutron-induced fission, prompt and delayed neutron emission, neutron cross sections, and the nuclear charge distribution are discussed. (J.W.R.)

32926 (CONF-681032-, pp 347-62) THERMAL NEUTRON FLUX DISTRIBUTION FROM A ^{252}Cf SPONTANEOUS-FISSION NEUTRON SOURCE. Magnuson, D. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (Y-DR-1).

Measurements were made of the spatial distribution of the thermal neutron flux near a ^{252}Cf spontaneous-fission neutron source in water. A maximum value of 0.0132 thermal neutrons/cm^2 per source neutron was found near the source and the distribution was in excellent agreement with fluxes previously calculated using the ANISN code. The californium was dispersed in aluminum and sealed in an aluminum cylinder, 0.364 in. o.d. and 0.75 in. long. The source strength was determined to be $(7.23 \pm 0.36) \times 10^8$ neutrons/sec. (auth)

32927 (GA-8133(Add.)) NEUTRON CROSS SECTIONS FOR NIOBIUM. Allen, M. S.; Drake, M. K. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 28, 1969. Contract AT(04-3)-167. 7p. Dep. CFSTI.

Neutron radiative capture cross sections and resonance parameters for ^{93}Nb for neutron energies of 1 keV to 15 MeV are tabulated. (J.W.R.)

32928 (IS-T-289) NUCLEAR DECAYS OF ^{97}Zr AND ^{97}Nb. Taff, Louis Michael (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 144p. Dep. CFSTI.

Thesis.

The beta and gamma radiations from 16.82 h ^{97}Zr and from 74 m ^{97}Nb were studied with scintillation and semiconductor detectors. Ge(Li) singles and Compton suppressed gamma-ray spectra, and Ge(Li)-Ge(Li) and Ge(Li)-NaI coincidence spectra established level schemes for ^{97}Nb and ^{97}Mo in good agreement with the recently reported work of Slivola and Graeffe. Levels in ^{97}Nb were placed at 743.2, 1147.8, 1250.8, 1276.3, 1548.2, 1750.1, 1764.3, 1851.1, 2105.6, and 2118.8 keV; some previously unreported but weak and tentatively assigned gamma rays were observed, but were not placed in the decay scheme. States were assigned in ^{97}Mo at 658.0, 720, 1024.5, 1116.8, 1268.5, 1515.0, and 1629 keV. Experiments on ^{97m}Nb yielded a new half-life value of 52.8 ± 0.2 sec, and set an upper limit of 0.4% on the beta decay of this isomer to the 658.0-keV level. ^{97m}Nb were measured to be $(1.65 \pm 0.15) \times 10^{-2}$ (K shell) and $(2.0 \pm 0.3) \times 10^{-3}$ (L + M shells); for the 658.0-keV ^{97}Mo transition they were $(1.74 \pm 0.17) \times 10^{-3}$ (K shell) and $(3.7 \pm 1.5) \times 10^{-4}$ (L + M shells). A Si(Li) detector was used to measure the end-point energy of the major beta group from ^{97}Zr and from ^{97}Nb; the resulting energies were (1883 ± 10) and (1296 ± 10) keV, respectively. Tentative spin assignments are suggested for most levels in ^{97}Nb and ^{97}Mo, and a brief discussion is given comparing these experimental levels with levels calculated theoretically by Vervier. An appendix describes a new internal conversion coefficient spectrometer utilizing semiconductor detectors. Other appendices concern the analysis of beta- and gamma-ray spectra on a digital computer. (auth)

32929 (IS-T-290) MEASUREMENTS OF GAMMA RAYS AND X RAYS WITH A BENT-CRYSTAL SPECTROMETER. Reierson, James Dutton (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 130p. Dep. CFSTI.

Thesis.

Gamma-ray energies and relative intensities have been measured with a two-meter bent-crystal spectrometer using quartz (310) and germanium (400) crystals. Gamma rays from ^{155}Sm, ^{152}Eu, ^{128}I, ^{180m}Hf, ^{175}Yb and ^{155}Eu were studied. A pneumatic system was used to transport short-lived activities from a reactor to the focal circle of the spectrometer. Using the pneumatic system, the following gamma-ray energies, in keV, were measured: ^{155}Sm: 104.320 ± 0.005, 141.411 ± 0.011, 245.727 ± 0.050; $^{152m_1}Eu$: 89.847 ± 0.006; $^{152m_2}Eu$: 121.775 ± 0.005; ^{128}I: 442.91 ± 0.07, 526.62 ± 0.10. Measurement of the energies of the gamma rays following the decay of ^{180m}Hf gave the following ^{180}Hf level energies: 93.332 ± 0.006 (2^+), 308.583 ± 0.014 (4^+), 640.89 ± 0.04 (6^+), 1084.07 ± 0.06 (8^+), 1141.62 ± 0.07 (8^-). The energies of the ground-state rotational band were compared with the predictions of several models. The gamma-ray energies and relative intensities, in parentheses, measured following ^{175}Yb beta decay to ^{175}Lu were: 113.803 ± 0.004, (29.0 ± 0.05); 137.656 ± 0.006, (1.56 ± 0.19); 144.861 ± 0.005, (5.20 ± 0.35); 251.470 ± 0.017, (1.37 ± 0.13); 282.517 ± 0.014, (46.5 ± 1.5); 396.322 ± 0.020, (100 ± 2.1). From these relative intensities and a measured value of 59.4 ± 1.6 for the Lu K x-ray relative intensity, the K-shell internal conversion coefficient for the 113.8-keV transition was determined to 1.90 ± 0.08. The gamma rays following the beta decay of ^{155}Eu to ^{155}Gd were investigated with the bent-crystal spectrometer. The following gamma-ray energies and relative intensities were measured: 60.006 ± 0.004; 86.541 ± 0.003, (100); 105.302 ± 0.005; 31.55 ± 0.10, (0.03 ± 0.02); 45.299 ± 0.002, (3.6 ± 0.7); 57.970 ± 0.026, (0.22 ± 0.05); 86.062 ± 0.023, (0.49 ± 0.05); 146.061 ± 0.015, (0.19 ± 0.02). Upper limits of 0.03 and 0.08 were put on the relative intensities of the undetected 40.7- and 118.0-keV gamma rays. From the relative intensity data it was concluded that 0.3% of the ^{155}Eu beta decays populate the 118.0-keV level in ^{155}Gd and 0.7% populate the 146.06-keV level. The spin assignments of the ^{155}Gd levels are discussed. (auth)

32930 (JINR-P7-4435) ON α DECAY OF SUPER-HEAVY NUCLEI. Muzychka, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 16p. Dep. CFSTI. (In Russian).

The energies of the α decay of super-heavy nuclei were estimated with the help of the Strutinsky method. The effect of single-particle potential parameters on the results of calculation of α decay energy was studied. The values of $T_{\frac{1}{2}}^{\alpha}$ for super-heavy nuclei were obtained. (auth)

32931 (LA-4108) FISSION CROSS SECTION OF ^{238}Pu FROM PERSIMMON. Silbert, M. G. (Los Alamos Scientific Lab., N. Mex.). Feb. 13, 1969. Contract W-7405-eng-36. 37p. Dep. CFSTI.

The neutron-induced fission cross section of ^{238}Pu was measured from 17 eV to 3 MeV. The nuclear explosion Persimmon provided an intense, single-pulse neutron source spanning an energy range of more than five decades. Neutrons from this underground source were sorted according to energy by time of flight over a 300-m vertical path and interacted with ^{238}Pu and with flux monitors at ground level. The cross section reported is the average from detectors at 55° and 80° to the neutron beam. (auth)

32932 (NP-17886) A NUMBER CONSERVING CALCULATION OF THE LOW ENERGY SPECTRA OF THE ODD-ODD Tl ISOTOPES. Internal Note No. 210. Iudice, N. Lo; Prosperi, D.; Salusti, E.; Stazi, O. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). Mar. 12, 1969. 17p. Dep.

A calculation is reported of the low-energy spectra of odd-odd Tl isotopes. The method is a simplified version of a theory first suggested to treat pairing correlations in nuclei without violating particle number conservation. The nn and pp interactions are schematized by pairing Hamiltonians. The np interaction is a contact force having a J-dependent amplitude which, as shown by Pandharipande, schematizes a force containing both central and tensorial components. (auth)

32933 THE CENTRIFUGAL STRETCHING MODEL AND THE DEVIATION FROM THE L(L + 1) RULE FOR RARE-EARTH NUCLEI. Wold, Einar (Univ., Oslo). Nucl. Phys., A130: 650-6(1969).

The deviation from the L(L + 1) rule for the deformed rare-earth nuclei is formulated in terms of the centrifugal stretching model of Sood. A two-parameter formula is presented which reproduces the general experimental trend. The result is discussed and compared with the results of Sood and Holmberg. (auth)

32934 K, L, AND M ELECTRON DIRECTIONAL CORRELATIONS IN ^{123}Te. Toernkvist, S.; Stroem, S.; Hasselgren, L. (Univ., Uppsala). Nucl. Phys., A130: 604-8(1969).

Directional correlations of the cascade in ^{123}Te involving K, L and M electrons from the 89 keV M4 transition were measured in order to determine the δ(E2/M1) value for the 159 keV transition. The result agrees with that from older correlation measurements, but is in conflict with values derived from Coulomb excitation and lifetime measurements as well as from L subshell ratios. (auth)

32935 SPIN-SPIN EFFECT IN THE ^{165}Ho TOTAL NEUTRON CROSS SECTION AT ENERGIES OF 0.4 AND 1.0 MeV. Fisher, T. R.; Healey, D. C.; McCarthy, J. S. (Stanford Univ., Calif.). Contract Nonr 225(67). Nucl. Phys., A130: 609-23 (1969).

Measurements of the spin-spin effect, σ_{ss} in the total cross section for polarized neutrons on polarized ^{165}Ho are reported at neutron energies of 0.4 and 1.0 MeV. The absence of an observable effect at 1.0 MeV is in contradiction with a recently reported experimental result. The results of an improved theoretical calculation of σ_{ss} for neutron energies below 8 MeV are presented and used with the new experimental data to obtain the new limit $|V_{ss}| <$ 300 keV for the strength of the spin-spin potential. (auth)

32936 THE DECAY OF 1.2 min ^{113m}Ag AND 5.3 h ^{113g}Ag. Hnatowich, D. J.; Coryell, C. D.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., A130: 497-512(1969).

The decay schemes of 1.2 min and 5.3 h ^{113}Ag were studied using Ge(Li) and NaI(Tl) detectors and a 4096-channel multiparameter pulse-height analyzer system. The decay of 5.3 h ^{113}Ag was found to involve 15 γ-rays and to populate 10 excited states in ^{113}Cd at energies of 264.7, 298.0, 315.6, 583.9, 604.6, 681.1, 883.6, 936.9, 989.0 and 1195.2 keV. The italicized energies refer to negative parity states, through which 1.3% of the decays go to yield the

14 y ^{111m}Cd ($11/2^-$) isomer at 264.7 keV. The 604.6 keV level is thought to be a $3/2^-$ level similar to those found in several odd-mass Te and Xe isotopes. The 1.2 min ^{113m}Ag decay was found to populate several of the same levels in Cd and two additional levels at 452 and 689 keV. The 1.2 min ^{113}Ag is the upper isomer with high spin, probably $7/2^+$. (auth)

32937 THE DECAY SCHEME OF ^{111}Ag. Sasaki, David T.; D'Auria, John M.; Pate, Brian D. (Simon Fraser Univ., Burnaby, B. C.). Nucl. Phys., A130: 687-95(1969).

The γ-radiations following the decay of ^{111}Ag were studied with Ge(Li) detectors. The ^{111}Ag half-life were measured as 3.16 ± 0.02 h; twenty gamma radiations ranging in energy from 606.7 to 2829.6 keV were observed. Gamma-gamma coincidence measurements were performed with Ge(Li) and NaI(Tl) detectors. A decay scheme consistent with the present data is proposed. (auth)

32938 EXCITED LEVELS OF ^{233}Pa. Vara, J. M.; Gaeta, R. (Junta de Energia Nuclear, Madrid). Nucl. Phys., A130: 586-94(1969).

The α-decay spectrum of ^{237}Np was measured with a semiconductor spectrometer of 18 keV effective resolution (FWHM). Over 13 new lines were identified. The γ-ray spectrum of ^{237}Np and ^{233}Th from 20 to 1000 keV was studied with high-resolution Ge(Li) and Si(Li) detectors. From these data and previous results, a more complete level scheme of ^{233}Pa is constructed. Nilsson assignments $1/2^-(530)$, $3/2^+(651)$ and $5/2^+(642)$ for rotational bands based on levels at 0, 86.6 and 237.7 keV are confirmed. A new $1/2^+(660)$ band whose lowest member is the level at 170.3 keV is identified and new levels with probable vibrational character are studied. (auth)

32939 THE DECAY OF ^{131}Cs. Fechner, J. (Univ., Bonn); Hammesfahr, A.; Kluge, A.; Sen, S. K.; Toschinski, H.; Voss, J.; Weigt, P. Nucl. Phys., A130: 545-62(1969).

In a study of the level scheme of ^{131}Cs, the γ-γ and the ce-γ directional correlations of the 496-123.7 and 486-133.5 keV cascades were measured. The linear polarization at $\theta = 90°$ was measured for the 496-123.7 and 486-133.5 keV cascades. The L-subshell ratios for the 123.7 keV transition were determined. The g-factor of the 133.5 keV level and the half-lives of the 78.7, 123.7, 133.5 and 216 keV levels were reinvestigated. The spin and parity assignments derived for the 620, 133.5 and 123.7 keV levels are $1/2^+$, $5/2^+$ and $1/2^+$, respectively. The 620, 496, 486, 133.5 and 123.7 keV transitions are found to be of pure E2, pure M1, pure E2, [M1 + (22 ± 2)%E2] and pure E2 multipolarity, respectively. An upper limit of 192 ps for the half-life of the 216 keV level is obtained. The results are compared with theoretical estimates from the calculations of Kisslinger and Sorensen, of Freed and of Freed and Miles. (auth)

32940 ANGULAR ANISOTROPY OF ^{241}Am NEUTRON-FISSION FRAGMENTS. Shpak, D. L.; Smirenkin, G. N. JETP Lett. (USSR) (Engl. Transl.), 9: 114-16(Feb. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 196-8(Feb. 5, 1969).

Detailed measurements were made of the angular distributions of fragments from the ^{241}Am(n,f) reaction at E_n = 0.3 to 7.2 MeV. (J.W.R.)

32941 PHOTONUCLEAR REACTION STUDY OF THE DEFORMATION OF ^{127}I NUCLEUS. Veyssiere, Andre; Beil, Hans; Bergere, Roland; Carlos, Pierre (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 268: 981-4(Apr. 9, 1969). (In French).

The study of the photonuclear reactions (γ,n), (γ,2n), and (γ,3n) on ^{127}I permits one to obtain the total cross section of photonuclear absorption σ_T (E). A representation of this total cross section by a sum of two Lorentz lines shows that the ^{127}I nucleus is a flattened ellipsoid with an intrinsic quadrupole moment $Q_0 = -2.3 \pm 0.4$ barns. (tr-auth)

32942 STUDY OF ^{117}I DECAY. Sergolle, Henri; Albouy, Georgette; Lagrange, Jean-Marie; Pautrat, Michele; Van Horenbeeck, Jean (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 283: 701-4(Mar. 3, 1969). (In French).

The study of γ radiation associated with the decay by β^+ emission and electron capture of ^{117}I allows one to propose two excited states of the isotope ^{117}Te having energies of 274.4 and 325.9 keV. These levels are compared with those observed in heavier odd-mass isotopes. (tr-auth)

32943 EXPERIMENTAL EVIDENCE OF DISAPPEARANCE OF THE INELASTIC CHANNEL OF THE NUCLEAR REACTION IN THE INTERACTION OF RESONANT γ RADIATION WITH NUCLEI AND ELECTRONS IN A SINGLE CRYSTAL. Voitovetskii, V. K.; Korsunskii, I. L.; Pazhin, Yu. F. (Inst. of Atomic Energy, Moscow). Phys. Lett., 28A: 779-81(Mar. 10, 1969).

The effect of disappearance of the inelastic channel of the nuclear reaction has been found. The effect is the nuclear analog of the Borrmann effect. (auth)

Nuclear Theory

Refer also to abstracts 32555, 32592, 32598, 32684, 32767, 32775, 32777, 32804, 32858, 32893, 32913, 32930, and 32933.

32944 (BMwF-FBK-68-63) HYDRODYNAMICAL CALCULATION OF EFFECTIVE MASSES OF BINARY FISSION. Hasse, R. W. (Wuerzburg Univ. (West Germany). Physikalisches Institut). Dec. 1968. 43p. (In German). Dep.

The kinetic part of the classical hamiltonian, which describes both symmetric and asymmetric nuclear fission, was computed as a quadratic form in the time derivatives of parameters determining the (sharp) nuclear surface. The nucleus is treated as an irrotational, nonviscous, and incompressible fluid and the problem is solved without using the "Wheeler assumption". An appropriate three-parameter description of the nuclear surface is chosen, and effective masses with respect to these parameters are computed numerically. Some of the results can be compared with those obtained by other authors. (auth)

32945 (BMwF-FBK-68-64) DYNAMIC MODEL OF ASYMMETRIC FISSION. Hasse, R. W. (Wuerzburg Univ. (West Germany). Physikalisches Institut). Dec. 1968. 42p. (In German). Dep.

A model is presented which describes the asymmetric mass distribution resulting from the low-energy fission process of the heavy elements. The nucleus is assumed to be a charged liquid drop but having an additional shell energy valid from the ground state up to the scission line and further on. The surface of the droplet is described by three parameters changing with time. The classical Hamilton's equations of motion of this system are solved numerically with random initial coordinates in the vicinity of the saddle point up to configurations of two separated fragments for the example $^{235}U + n_{th}$. The resulting distributions of mass and kinetic energy of the fragments and the variances of the kinetic-energy distribution are compared with experiments. (auth)

32946 (BMwF-FBK-69-9) REPORT ON INVESTIGATIONS ON THE CLUSTER MODEL OF THE ATOMIC NUCLEUS, 1967-1968. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Mar. 1969. 125p. (In German). Dep.

Investigations in the framework of the cluster model of the atomic nucleus (1967/68) included nuclear reaction theory; special investigations on light nuclei; application of group-theoretical methods; and some contributions to high-energy physics. (auth)

32947 (CCDN-NW-8) NEWSLETTER NO. 8 BULLETIN. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). Mar. 1969. 403p. Dep.

An index is presented for the NNCS/CCDN computerized file on neutron data of Brookhaven National Laboratory and the ENEA Neutron Data Compilation Centre. (J.W.R.)

32948 (CCDN-NW-9) NEWSLETTER NO. 9. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). Apr. 1969. 83p. Dep.

A compilation of neutron cross section evaluations available as of March, 1969, is presented. (J.W.R.)

32949 (CNAEM-46) PROGRESS REPORT, JANUARY 1, 1967-JUNE 30, 1967. (Cekmece Nuclear Research Center, Istanbul (Turkey)). 22p. (In Turkish). Dep.

The research carried on in chemistry, diffractometry, spectrometry, theoretical physics, plasma physics, radiobiology, nuclear engineering, and electronics is briefly summarized. The operation of the TR-1 research reactor and health physics services are reviewed. Technical information services are also briefly discussed. (C.E.S.)

32950 (CTC-12) POPOP4: A CODE FOR CONVERTING GAMMA-RAY SPECTRA TO SECONDARY GAMMA-RAY PRODUCTION CROSS SECTIONS. Ford III, Walter E.; Wallace, David H. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). May 23, 1969. Contract W-7405-eng-26. 89p. Dep. CFSTI.

POPOP4 is a FORTRAN IV program which converts spectra of gamma-rays from neutron-induced reactions to a required neutron-gamma energy group structure. If the spectra are given in terms of gamma intensity per reaction, POPOP4 will multiply the converted spectra by input reaction cross sections to produce secondary gamma-ray production cross sections. The code will also convert secondary gamma-ray cross sections from a given neutron-gamma energy group structure to a required neutron-gamma

energy group structure. POPOP4 will make, update, or read a hexadecimal library tape of spectral data. The conversion technique used in POPOP4 is described for the various forms of spectra which are found in the literature. The input data required to execute the various options are also described. The input and output for a sample problem are shown. Using another code, secondary gamma-ray production cross sections calculated by POPOP4 can be coupled with the P_0 components of the neutron and gamma-ray cross sections for the nuclides of interest. The coupled multigroup cross sections can then be used with codes such as ANISN, DOT, and O5R. (auth)

32951 (ITF-69-18) CORRELATION FUNCTIONS FOR THE NUCLEAR MATTER. Filippov, G. F.; Steshenko, A. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 12p. (In Russian). Dep.

Nuclear matter is considered as an infinite lattice of the nucleon system. The correlation function for such a model of nuclear matter is built up and calculated. The correlation function is also calculated for the shell model of nuclear matter with one-particle oscillator functions being used. A comparison of the correlation functions of the two models is made. (auth)

32952 (LA-4049) RAYMATH: A FORTRAN IV CODE TO COMPILE SIMPLE INSTRUCTIONS FOR ARRAY MATHEMATICS AND MANIPULATION. Harlow, M. V. Jr.; Neergaard, J. R. (Los Alamos Scientific Lab., N. Mex.). Nov. 19, 1968. Contract W-7405-eng-36. 120p. Dep. CFSTI.

To facilitate analysis of experimental neutron cross-section data, a computer code was written in FORTRAN IV to compile a set of special instructions. Six floating-point arrays, each 6000 entries long, and four floating-point constants are employed in the code. Input/output and mathematical manipulations between these arrays and constants are carried out by these instructions. (auth)

32953 (LIB/Trans-200) FUNCTION OF THE AVERAGE KINETIC ENERGY OF FISSION FRAGMENTS OF HEAVY NUCLEI. Okolovich, V. N. Translated by Paul Pakalns (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Vestn. Akad. Nauk Kaz. SSR, 21: No. 7, 58-62 (July 1965). 9p. Dep.

A review is given of experimental data on the energy dependence of the mean kinetic energy of heavy nucleus fission fragments. Three characteristic energy regions of fissioning nuclei were analyzed: pre-threshold, near threshold, and above barrier fissions. The included diagrams show characteristic irregularities of the dependence on neutron energies in ^{233}U and ^{235}U. The results of the analysis indicated that the energy dependence of the mean kinetic energy of various fission fragments from 0 to ~25 MeV is not in agreement with Fowler hypothesis either at low or high above threshold fission energy. (auth) (Australia)

32954 (NP-17910) ANNUAL REPORT, 1965-66. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark)). 46p. (In Danish and English). Dep.

The staff, activities, and lists of publications and lectures on nuclear and high-energy physics at Nordita during July 1, 1965, to June 30, 1966, are presented. (W.H.K.)

32955 (NYO-3829-31) SEPARABILITY OF TWO PARTICLE POTENTIALS. Pratt, R. H. (Pittsburgh Univ., Pa. Dept. of Physics). Mar. 1969. Contract AT(30-1)-3829. 7p. Dep. CFSTI.

The quantum mechanical problem of two particles in a harmonic oscillator potential is tractible even if the particles interact, because the Hamiltonian can be separated in relative and center of mass coordinates for the two particles. It is shown that this situation is also possible for more general potentials, permitting use of the method in describing deformed nuclei or in external fields. The case of unequal masses, as in a hypernucleus, is also discussed. (auth)

32956 (PUC-937-363) PRESENT STATUS OF THE ISOBARIC MULTIPLET MASS EQUATION. Garvey, G. T. (Oxford Univ. (England). Dept. of Nuclear Physics). Mar. 1969. 22p. (CONF-690310-6). Dep. CFSTI.

From Conference on Isobaric Spin, Pacific Grove, Calif.

The current status of knowledge about the energy splittings of isospin multiplets is discussed without recourse to the explicit description of the wave functions. The isobaric multiplet mass equation is developed and its limitations discussed. (J.W.R.)

32957 DEFORMED POTENTIAL MANY-PARTICLE THEORY. Draayer, Jerry Paul. Ames, Iowa, Iowa State Univ., 1968. 161p. Thesis.

The relation between the U(3) ⊃ R(3) state labeling scheme introduced by Elliott for a description of many particles moving in an isotropic harmonic oscillator potential and the Gel'fand U(3) ⊃ U(2) × U(1) state labeling scheme introduced by Nagel and Moshinsky is established. A rule complementary to the one given by Elliott for the quantum number K required in the U(3) ⊃ R(3) reduction is given and the use of K in state labeling is clarified. An explicit expression for the transformation brackets between the two state labeling schemes is obtained and the results used to derive an explicit expression for both the U(3) ⊃ R(3) coupling coefficients and projected tensor matrix elements. Application of the invariance of the commutators of the infinitesimal generators of U(3) to a canonical transformation is used to generalize these results to a deformed potential many-particle theory. An expansion of the deformed potential many-particle states in terms of the nondeformed potential many-particle states is made. A phenomenological description of the motion of nucleons in a deformed potential created by a deformed core which itself is allowed to rotate adiabatically is presented. An application to the A = 18 system is made, treating ^{18}O as having two particles moving in a deformed potential created by the ^{16}O core. (Disser. Abstr.)

32958 COULOMB INTERFERENCE IN THE ELASTIC SCATTERING OF POLARIZED PROTONS ON NUCLEI. Beltrametti, E. G. (Univ., Genoa); Zambotti, G. Nuovo Cim., 61A: 333-43 (June 1, 1969).

The role of the Coulomb nuclear interference in the asymmetry arising in the elastic scattering of polarized protons is investigated by a phase-shift calculation, large effects are found for medium heavy nuclei and for energies in the range (75 ÷ 200) MeV. The meaning of the "polarization-asymmetry equality" in the interference region is briefly discussed. (auth)

32959 GEOMETRIC FACTORS IN NUCLEAR STRUCTURE. Pauling, Linus C. pp 83-8 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968.

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

The cluster or spheron model of the nucleus is described and applied to explaining some nuclear properties. The structure and magnetic moments of light nuclei, magic numbers, and the prolate deformation of heavier nuclei are explained in terms of the spheron model. (J.W.R.)

32960 PROSPECTS OF SYNTHESIZING NEW ISOTOPES AND ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 105-24 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968. (In Russian and English).

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

The methods used in producing elements Z = 100 through 102 are reviewed and methods currently being used to produce or search for Z > 102 elements are described. (J.W.R.)

32961 PRESENT-DAY PROBLEMS OF NUCLEAR STRUCTURE. Bohr, Aage. pp 45-62 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968.

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

The current research on nuclear structure is surveyed, some of the problems encountered are described. (J.W.R.)

32962 FINE STRUCTURE, PARTIAL WIDTHS, AND SPREADING WIDTHS OF ISOBARIC ANALOGUE RESONANCES. Mahaux, C. (Univ., Liege); Weidenmueller, Hans A. Nucl. Phys., A130: 481-96(1969).

Formulas for the microscopic calculation of partial widths and spreading widths, derived from several theories of the isobaric analogue resonances, are compared and critically examined. It is shown that the statistical assumptions used in the derivation of these formulas are not in contradiction with the fine-structure data, in contrast to recent speculations. The accuracy with which partial and spreading widths can be calculated is discussed. The theoretical values of the partial widths, and thus the determination of the spectroscopic factors, involve poorly known phenomenological parameters (essentially the shape of the symmetry potential). Then, only relative values of the spectroscopic factors can at present be accurately determined. The calculation of the spreading width depends critically upon our knowledge of isospin violation in the nucleus. Recent calculations of the spreading widths are reexamined in the light of these results. (auth)

32963 NUMERICAL COMPARISON OF REACTION-MATRIX AND JASTROW METHODS FOR NUCLEAR MATTER. Baeckman, S.-O. State Univ. of New York at Stony Brook); Chakkalakal, D. A.; Clark, J. W. Contract AT(30-1)-4032. Nucl. Phys., A130: 635-49(1969).

The ground-state energy per particle of symmetrical nuclear

matter was calculated as a function of Fermi wave number for two representative central potentials containing hard cores, by means of both reaction-matrix and Jastrow methods. The agreement of results from the two methods is remarkably good in the density region near equilibrium. (auth)

32964 ISOBARIC SPIN MIXING FROM SELF-CONSISTENT TREATMENT OF COULOMB INTERACTION. Khadkikar, S. B. (Inst. of Fundamental Research, Bombay); Warke, Chindhu S. Nucl. Phys., A130: 577-85(1969).

From a self-consistent independent-particle model of the nucleus, isobaric spin mixing in the ground state of nuclei is calculated for the mass region $4 < A < 208$. From this model, allowed Fermi β-decay matrix elements are calculated. The Coulomb energy differences calculated from our model turn out to be about the same as those obtained from the (p,n) reaction data. A relation of the direct Coulomb energy of a nucleus to its elastic form factor is pointed out. (auth)

32965 HIGH-ENERGY ELECTRON-SCATTERING AND MODEL INDEPENDENT DESCRIPTION OF CHARGE-DISTRIBUTIONS IN NUCLEI. Lenz, F. (Univ., Freiburg i. B.). Z. Phys., 222: 491-503(1969). (In German).

A method is given to evaluate in a model independent way cross sections for scattering of fast electrons by nuclei. For this purpose the charge distribution in the nucleus will not, as usual, be described by means of the charge density $\rho(r)$, but by the first moment function $T(Q) = \int_0^Q r(Q')dQ'$. The integration has to be performed over this part of the charge distribution in which the charge will increase from the value 0 to the value Q. Thus T(Q) gives the first moment of this part. It may be shown that this function can be fixed by elastic scattering within certain limits. (auth)

32966 ISOBARIC ANALOG RESONANCES. Coker, W. Rory (Univ. of Texas, Austin); Moore, C. Fred. Phys. Today, 22: No. 4, 53-61(Apr. 1969).

The foundations of isobaric-spin formalism are reviewed and experimental observations supporting the use of isobaric spin as a valid quantum number are discussed. The data on isobaric analog resonances seen in proton elastic scattering and (p,n) reactions on medium to heavy nuclei are surveyed. The nuclear-structure information that may be obtained from isobaric analog resonance is discussed. (J.W.R.)

32967 SU_3 ALGEBRA IN THE MIXED-SHELL SPACE (0p, 0d, 1s). I. Ishidzu, Takehiko (Tokyo Univ.); Kawarada, Hideo; Sato, Masachiyo. J. Math. Phys. (N. Y.), 10: 683-8(Apr. 1969).

The operators of Elliott are extended in such a way that they also describe an SU_3 algebra in the mixed-shell space $\mathcal{M}^*$, where $\mathcal{M}^*$ is given as the direct sum of two spaces $\mathcal{M}(0p)$ and $\mathcal{M}(0d,1s)$ spanned by the single-particle wavefunctions in the (0p) and (0d,1s) shells of a harmonic-oscillator potential. The representation of SU_3 in this space $\mathcal{M}^*$ is investigated in detail by the aid of the weight diagram in a way analogous to that of Banerjee and Levinson. The basis is expressed in an explicit manner using the one-particle wavefunctions in the usual shell model. The states arising from two- and three-particle systems are classified according to the irreducible representations in this extended space. (auth)

32968 LEVEL DENSITY OF A FERMI SYSTEM: NONPERIODIC PERTURBATIONS OF THE ENERGY LEVEL SCHEME. Kahn, Peter B. (State Univ. of New York, Stony Brook. Weizmann Inst. of Science, Rehovoth, Israel); Rosenzweig, N. J. Math. Phys. (N. Y.), 10: 707-15(Apr. 1969).

The level density of a degenerate Fermi system is modified by the perturbation in the position of a single-particle level. To study this effect, miscellaneous exact relations between the level densities of the perturbed and unperturbed system are derived. For the special case of the perturbed uniform model, these connections become a set of recursion relations which lead to a complete solution of the problem. Results are also obtained in the saddle-point approximation, and these have a simple interpretation in terms of the usual Fermi occupation probabilities. If a single-particle level is deleted from the scheme, the resultant diminution in the level density persists indefinitely with increasing excitation energy. Information about the adequacy of the saddle-point approximation is obtained by comparison with some exact solutions. (auth)

32969 NUCLEAR REACTIONS AS AN EXAMPLE OF THE QUANTUM THEORY OF IRREVERSIBLE PROCESSES. Weidlich, W. (Univ., Stuttgart). Z. Phys., 222: 403-24(1969).

A density matrix formalism is developed for nuclear reactions, where the nuclear system is described by an effective Hamiltonian in second quantization, including potential scattering and different compound nucleus reactions. On the other hand, the nuclear system is coupled to reservoirs injecting and absorbing particles, such that the stationary solution of the irreversible density matrix equation describes a "flux-equilibrium." Taking appropriate expectation values, the set of coupled equations is solved for potential scattering and especially for a compound nucleus reaction. The cross sections are calculated, showing the Breit–Wigner resonance structure in the latter case, where the level width is expressed in terms of the matrix elements contained in the fundamental Hamiltonian. (auth)

32970 QUADRUPOLE DIRECT CAPTURE. Longo, G.; Saporetti, F. (Comitato Nazionale Energia Nucleare, Bologna). Nuovo Cim. 61B: 167-76(May 1969).

An expression of the cross section for the quadrupole radiative capture of nucleons by nuclei via direct mechanism is given. The $^{142}Ce(p,\gamma)$ reaction is investigated in the 10 to 50 MeV energy range. It is shown that for proton energies above 20 MeV the quadrupole contribution to the cross-section may be of the same order of magnitude as the dipole one. (auth)

32971 SATURATION OF THE CABIBBO–RADICATI SUM RULE IN NUCLEAR PHYSICS. Leonardi, R. (Univ., Bologna); Rosa-Clot, M. Nuovo Cim., 61B: 100-18(May 11, 1969).

The Cabibbo–Radicati sum rule is generalized to spin J and isospin T. The evaluation of the sum rule is performed in detail for nuclei with $A \leq 50$ and rather good approximations are given for nuclei with $A > 50$. By using some simple models and the Levinger nuclear sum rules, a good agreement is found with experimental data. The available nuclear models are less accurate than what is required by the sum rule, so it is not possible to consider the result as a test of current algebra. (auth)

32972 ON TWO-PARTICLE CONTINUUM COULOMB WAVE FUNCTIONS. Weber, H. J. (Univ. of Virginia, Charlottesville). Nuovo Cim., 61B: 131-40(May 11, 1969).

The experimental measurement of multiple-particle scattering cross sections using a definite arrangement of detectors, thereby defining the boundary conditions of the scattering process, suggests the introduction of coordinates which incorporate the channel energy partition among the outgoing particles. As a consequence, for fixed channel energy, the multiple-particle continuum channel states represent a discrete basis. It is shown that a central nuclear and the Coulomb potential can be incorporated into the channel wave functions which then are extended to the internal nuclear-interaction region using the eigenchannel formulation of R-matrix theory. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 32029.

32973 (APDA-CFE-28) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, DECEMBER 1968. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Apr. 1969. Contract AT(11-1)-865. 47p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Tools and methods for removal of the Zr segments and screw heads are described. The vacuum cleaner designed for insertion through the 14 inch Na inlet pipe is illustrated. Thermal shock test and hydraulic test results for No. 3 boiler are presented. Operations and maintenance requirements for the month of December, 1968, are described. (D.C.C.)

32974 (CONF-681101–35) EARTHQUAKE RESISTANT DESIGN FOR NUCLEAR POWER PLANTS. Muto, Kiyoshi (Kijima Construction Co. Ltd., Tokyo (Japan)); Hisada, Toshihiko (Ministry of Construction, Tokyo (Japan). Building Research Inst.). [1968]. 25p. Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The basic philosophy of aseismic design of nuclear power plant buildings, structures, equipment, piping, and instruments is presented. Site selection criteria are discussed. The present status of the aseismic design of plants in the U.S. and Japan is examined by using the Tokai Nuclear Power Plant, Tsuruga Nuclear Power Plant, and San Onofre Nuclear Power Plant as examples. Typical aseismic devices used in these plants are explained. Problems for future study in the field of earthquake engineering are discussed. (H.D.R.)

32975 (DOCKET-50010–1) DRESDEN GENERATING STATION, [UNIT 1]: ENVIRONMENTAL FACTORS AT PROPOSED SITE. (Commonwealth Edison Co., Chicago, Ill.). June 15, 1955. 66p. (NPG–126). Dep. CFSTI.

A site analysis for the Dresden Power Reactor, Unit 1 is given. Population and surrounding activities are discussed; data are given on the geology, seismology, hydrology, and meteorology. Detailed climatological data are included, also. (M.L.S.)

32976 (DOCKET-50010–2) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Preliminary Hazards Summary Report. (Commonwealth Edison Co., Chicago, Ill.). Sept. 3, 1957. 224p. (GEAP–1044(Rev.)). Dep. CFSTI.

Information on Dresden Power Reactor, Unit 1 is given on the following broad topics: Description of the Plant; Nuclear Characteristics of the Reactor; the Site and its Environment; Waste Disposal; Operation; and Safety Analyses. (M.L.S.)

32977 (DOCKET-50010–3) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Operating Procedures and Emergency Plans. (Commonwealth Edison Co., Chicago, Ill.). June 5, 1958. 94p. (GEAP–2071). Dep. CFSTI.

Operating procedures and emergency plans are included for the Dresden Power Reactor, Unit 1. Complete procedures are listed for initial startup, startup after prolonged shutdown, hot startup, normal shutdown, and refueling. (M.L.S.)

32978 (DOCKET-50010–4) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Technical Specifications. (Commonwealth Edison Co., Chicago, Ill.). Jan. 6, 1959. 25p. (GEAP–3082). Dep. CFSTI.

Salient features of the Dresden Power Reactor, Unit 1 are summarized. The complete set of Technical Specifications is included. (M.L.S.)

32979 (DOCKET-50010–5) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Technical Specifications. (Commonwealth Edison Co., Chicago, Ill.). Feb. 6, 1959. 26p. (GEAP–3082 (Rev.)). Dep. CFSTI.

A revised set of Technical Specifications for the Dresden Power Reactor, Unit 1 is given. This set supersedes the original submittal. (M.L.S.)

32980 (DOCKET-50010–6) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Preliminary Hazards Summary Report, Amendment 1. (Commonwealth Edison Co., Chicago, Ill.). May 26, 1958. 103p. (GEAP–3009). Dep. CFSTI.

Revised information on the Dresden Power Reactor, Unit 1 is given on the following subjects: nuclear characteristics, fuel enrichment, burnable poison, reactor design parameters, control rod drives, safety instrumentation, and safety analyses. Details of fuel element design are given. Functioning and operations characteristics of the control rod accumulator are discussed; pressure characteristics are shown graphically. Fuel cycling and fuel burnup effects are analyzed. Cold water accidents and startup accidents are discussed in detail; systems and core stability is assessed. (M.L.S.)

32981 (DOCKET-50010–7) DRESDEN NUCLEAR POWEI STATION, [UNIT 1]. Preliminary Hazards Summary Report, Amendment 2. (Commonwealth Edison Co., Chicago, Ill.). Aug. 25, 1958. 21p. (GEAP–3053). Dep. CFSTI.

Changes in values for reactivity worths of control rods and poisons in the Dresden Power Reactor, Unit 1 core are tabulated. An analysis of a 5-rod startup analysis is given. Effects of a large break in one of the bottom coolant inlet lives are analyzed. (M.L.S.)

32982 (DOCKET-50010–8) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Preliminary Hazards Summary Report, Amendment 3. (Commonwealth Edison Co., Chicago, Ill.). Dec. 29, 1958. 129p. (GEAP–3076). Dep. CFSTI.

Revised information on the original safety analysis report on the Dresden Power Reactor, Unit 1 is given on the introduction and summary, technical summary, process systems, plant description, nuclear characteristics of the reactor, waste disposal, operation, safety analyses, operating procedures, and emergency plans. (M.L.S.)

32983 (DOCKET-50010–9) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. [Preliminary] Hazards Summary Report, Amendment 4. (Commonwealth Edison Co., Chicago, Ill.). Feb. 6, 1959. 25p. (GEAP–3106). Dep. CFSTI.

Revisions to Dresden Power Reactor, Unit 1 control rod systems data are given; revised data on core nuclear characteristics, flux monitor system, and additional data on the negative pressure design for the containment are included, also. (M.L.S.)

32984 (DOCKET-50010–10) CONTROL AND TRANSIENT PERFORMANCE OF THE DRESDEN NUCLEAR POWER STATION. Collett, W. I.; Owen, E. R. (General Electric Co., [San Jose, Calif.]). [nd]. 26p. (CONF-610604–1; CONF-610804–1). Dep. CFSTI.

From AIEE Summer General Meeting, Ithaca, N. Y. Pacific General Meeting, Salt Lake City, Utah.

Results of control and transient performance tests on the Dresden Power Reactor, Unit 1 are discussed. Salient features of plant design are summarized; steady state control and dual cycle performance are discussed; test instrumentation is described. All data are shown graphically. (M.L.S.)

32985 (DOCKET-50010–11) [DRESDEN NUCLEAR POWER STATION, UNIT 1]: GENERAL DESIGN AND ELECTRICAL FEATURES. (Commonwealth Edison Co., Chicago, Ill.). [nd]. 26p. Dep. CFSTI.

A general description of the Dresden Power Reactor, Unit 1 and its site is given. The dual steam cycle, which the reactor utilizes, is described; a flow diagram is included. The fuel handling system, pressure vessel and control rods are described. The electrical systems and reactor protective instrumentation are discussed. Flow diagrams and cutaways of the systems are shown. (M.L.S.)

32986 (DOCKET-50010–12) [DRESDEN NUCLEAR POWER STATION, UNIT 1]. [Preliminary Hazards Summary Report], Appendix A. (Commonwealth Edison Co., Chicago, Ill.). Jan. 23, 1958. 24p. Dep. CFSTI.

A description of the 9-rod fuel element for the Dresden Power Reactor, Unit 1 is given. Design data, a sample loading pattern to include this type of fuel element in an otherwise plate-type core, and a discussion of the mixed loading effects on reactor stability are included. (M.L.S.)

32987 (DOCKET-50010–13) NEUTRON AND PARALLEL FLOW CHANNEL COUPLING EFFECTS ON THE T-7 FLUX TRAP REACTOR. Case, J. M. (General Electric Co., San Jose, Calif.

Atomic Power Equipment Dept.). Aug. 15, 1960. Contract AT(04-3)-189. 41p. (GEAP-3508). Dep. CFSTI.

An analytical model and analog computer simulation of neutron and parallel flow channel coupling in a large BWR are discussed. Schematics and flow diagrams of the dual flow channel are described; the mathematical models for the thermo-hydraulics and the coefficient of reactivity calculations are given. The traces of the analog computer solutions are included. Results of the simulation are discussed. (M.L.S.)

32988 (DOCKET-50010-14) THE STABILITY OF TWO-PHASE FLOW LOOPS AND RESPONSE TO SHIP'S MOTION. Beckjord, E. S. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 26, 1960. Contract AT(04-3)-189. 48p. (GEAP-3493(Rev.1)). Dep. CFSTI.

32989 (DOCKET-50010-15) [DRESDEN NUCLEAR POWER STATION, UNIT 1]. [Preliminary Hazards Summary Report], Suppl. 3. (Commonwealth Edison Co., Chicago, Ill.). Oct. 11, 1960. 29p. Dep. CFSTI.

The complete authorization for the issuance of the operating license, DPR-2, to Dresden Power Reactor, Unit 1 is presented. The examination of records and Commission findings are included in detail. (M.L.S.)

32990 (DOCKET-50010-16) FUEL CYCLE PROGRAM: A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Third Quarterly Report, January-March 1961. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Contract AT(04-3)-189. 37p. (GEAP-3709). Dep. CFSTI.

32991 (DOCKET-50010-17) DRESDEN NUCLEAR POWER STATION. First Quarterly Report of Station Operation, July 4-December 31, 1960. (Commonwealth Edison Co., Chicago, Ill.). Jan. 25, 1961. 13p. Dep. CFSTI.

Operation of the Dresden Power Reactor, Unit 1 for the period July 4-December 31, 1960 is summarized. Some details on control rod drive inspection and load reductions are given. Unscheduled scrams are listed; disposal of radioactive waste is described. Reactor and turbine generator service records are included. (M.L.S.)

32992 (DOCKET-50010-18) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. Addendum No. 1 to the Report on Dresden Control Rod Drive Modification. (Commonwealth Edison Co., Chicago, Ill.). Feb. 20, 1961. 65p. Dep. CFSTI.

Details on the control rod drive modifications for the Dresden Power Reactor, Unit 1 are given. Parts of the rod drives which were replaced are listed. Specifications for procurement and fabrication of replacement parts are detailed. Results of drive testing are given. Drive removal and inspection procedures are included. (M.L.S.)

32993 (DOCKET-50010-19) [DRESDEN NUCLEAR POWER STATION, UNIT 1]: MATERIAL AND FABRICATION OF BOTTOM CORE SUPPORT ASSEMBLY. (Commonwealth Edison Co., Chicago, Ill.). Apr. 18, 1961. 11p. Dep. CFSTI.

Specifications for materials for the bottom core support assembly are listed. Fabrication and inspection procedures for the assembly are included. (M.L.S.)

32994 (DOCKET-50010-20) [DRESDEN NUCLEAR POWER STATION, UNIT 1]: BOTTOM CORE SUPPORT ASSEMBLY. (Commonwealth Edison Co., Chicago, Ill.). May 8, 1961. 23p. Dep. CFSTI.

Design drawings for the bottom core support assembly for the Dresden Power Reactor, Unit 1 are given. A complete stress analysis of the core support assembly is presented; this includes mechanical loading, gamma heating stress, and thermal shock analyses. (M.L.S.)

32995 (DOCKET-50010-21) [DRESDEN NUCLEAR POWER STATION, UNIT 1]: RESPIRATORY PROTECTIVE EQUIPMENT. Exhibit A. (Commonwealth Edison Co., Chicago, Ill.). July 11, 1961. 9p. Dep. CFSTI.

Respiratory protective equipment to be used by Dresden Power Reactor, Unit 1 personnel is described. Procedures governing its use are given. (M.L.S.)

32996 (DOCKET-50010-22) DRESDEN NUCLEAR POWER STATION, [UNIT 1]. [Preliminary Hazards Summary Report], Supplemental Data on the Proposed High Steam Void Test. (Commonwealth Edison Co., Chicago, Ill.). Sept. 16, 1961. 10p. Dep. CFSTI.

Burnout correlations for low mass flow rates for the high void tests in the Dresden Power Reactor, Unit 1 are tabulated. Coolant quality at burnout point is shown as a function of heat flux; stability during testing is analyzed; test conditions are listed. Reactor pressure transients are analyzed; data are shown graphically. (M.L.S.)

32997 (DOCKET-50331-9) DUANE ARNOLD ENERGY CENTER. Preliminary Safety Analysis Report, Amendment 3. (Iowa Electric Light and Power Co., Cedar Rapids). Apr. 25, 1969. 168p. Dep. CFSTI.

The quaitity assurance program for the Duane Arnold Power Reactor is detailed. Maximization factors for storms in the Minnesota River Basin are given. Revised or additional pages are included for all sections of the original Preliminary Safety Analysis Report. (M.L.S.)

32998 (DOCKET-50334-5) BEAVER VALLEY POWER STATION. [Preliminary Safety Analysis Report], Amendment 2. (Duquesne Light Co., Pittsburgh, Pa.). Apr. 22, 1969. 46p. Dep. CFSTI.

Details of the quality assurance program for the Beaver Valley Power Reactor are included. Organization of the Stone and Webster Engineering Corporation is detailed; the quality assurance plan of the Westinghouse PWR Division is described. (M.L.S.)

32999 (DOCKET-50335-4) HUTCHINSON ISLAND PLANT, UNIT NO. 1. [Preliminary Safety Analysis Report], Amendment 1-I. (Florida Power and Light Co.). Apr. 2, 1969. 32p. Dep. CFSTI.

Details of site foundation studies for Hutchinson Island Power Reactor, Unit 1, are given. Excavation procedures, boring plans, and soils properties are presented graphically. (M.L.S.)

33000 (DOCKET-50335-5) HUTCHINSON ISLAND PLANT, UNIT NO. 1. [Preliminary Safety Analysis Report], Amendment 1-II. (Florida Power and Light Co.). Feb. 14, 1969. 209p. Dep. CFSTI.

Test boring records at the site for the Hutchinson Island Power Reactor, Unit 1, are included. Boring plans are shown; results of split spoon sampling, undisturbed sampling, auger borings, and piezometer borings are given. (M.L.S.)

33001 (DOCKET-50335-6) HUTCHINSON ISLAND PLANT, UNIT NO. 1. [Preliminary Safety Analysis Report], Amendment 1-III. (Florida Power and Light Co.). Feb. 14, 1969. 253p. Dep. CFSTI.

Grain size classifications of soils at the Hutchinson Island Power Reactor, Unit 1 site, are tabulated according to boring number; grain size distributions are shown graphically. Results of soil consolidation tests are given. Characteristics of fill materials are detailed. (M.L.S.)

33002 (EUR-4234) DETERMINATION OF INTRINSIC REACTIVITY VARIATIONS OF THE LATINA REACTOR. Final Report. Ariemma, A.; Bellia, G.; Calabresi, F.; Gualtieri, G.; Lesnoni la Parola, G.; Marzullo, T.; Paoletti Gualandi, M.; Zeffiro, B. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Dec. 11, 1969. 108p. Dep.

The performance of a natural-uranium gas-graphite reactor is closely dependent, throughout the station lifetime, on an accurate fuel and absorber cycle programming. This programming entails the knowledge of the reactivity variation as a function of irradiation, and an accurate assessment of the reactivity controlled by various factors, namely absorbers, xenon, boron contained in the graphite, control rods and temperature effects. For each general condition of core irradiation, the algebraic sum of the deviations of reactivity components controlled by the mentioned factors from the reference values represents the intrinsic reactivity variation from the initial core conditions. The execution of these reactivity balances, extended to the first four years of reactor operation, permitted the intrinsic reactivity variation of the Latina reactor to be known as a function of the energy generated. The reactivity balances were performed on the basis of experimental data and calculation methods whose validity was verified by comparison with the results of measurements purposely taken. The results obtained for the intrinsic reactivity variation are generally in good agreement with similar data relating to other reactors of the same type and provide a valid contribution to data availability. 61 references. (auth)

33003 (ORNL-NSIC-62) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE-19. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 343p. Dep. CFSTI.

A bibliography on nuclear safety is presented. Material is categorized according to: General Safety Criteria; Siting of Nu-

clear Facilities; Transportation and Handling of Radioactive Materials; Aerospace Safety; Accident Analysis; Reactor Transients, Kinetics and Stability; Fission Product Release, Transport, and Removal; Sources of Energy Release Under Accident Conditions; Nuclear Instrumentation, Control, and Safety Systems; Electrical Power Systems; Containment of Nuclear Facilities; Plant Safety Features; Radionuclide Release and Movement in the Environment; Environmental Surveys, Monitoring, and Radiation Exposure of Man; Meteorological Considerations; Operational Safety and Experience; and Safety Analysis and Design Reports. (D.C.C.)

33004 (ORNL-TM-2385) POWER PLANT CAPITAL COST NORMALIZATION. Lane, J. A.; Myers, M. L.; Olson, R. C. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 70p. Dep. CFSTI.

Capital costs of eight basic types of 1000-MW(e) reactor plant concepts of principal interest in the civilian nuclear power program were normalized to a common set of ground rules and applicable unit cost data, and for comparison estimates of the capital costs of 1000-MW(e) fossil-fuel-fired power plants were prepared with the same ground rules. The capital costs are presented relative to those of a light-water reactor plant estimated to cost $133/kW(e), based on June 1967 dollars. Reasons for differences in costs between the various concepts are discussed in system-by-system comparisons. Influences on construction costs of factors such as allowances for sales tax, escalation, and extended work weeks were also determined. With these allowances included in the costs, it is estimated that a 1000-MW(e) PWR plant started in June 1968 would cost $163/kW(e) to complete, and a 1000-MW(e) coal-fired plant started at the same time would cost $145/kW(e) to complete. 29 references. (auth)

33005 (WCAP-3269-7) SAN ONOFRE NUCLEAR GENERATING STATION REFERENCE CORE DESIGN. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Mar. 1965. Contract AT(30-1)-3269. 49p. Dep. CFSTI.

The reference design parameters for the pressurized light water moderated and cooled reactor core are presented. Pertinent mechanical, thermal and hydraulic, and nuclear design data are presented, and considerations affecting the selection of the design concepts and specific values of design parameters are given. Also included are considerations leading to the selection of core materials. (auth)

33006 FRENCH NUCLEAR PROGRAM DIRECTIONS. Energ. Nucl. (Paris), 11: 72-8(Mar.-Apr. 1969). (In French).

The conditions required for organizing a national nuclear industry in France are described. Joint nuclear power programs with European countries are analyzed. (auth)

33007 THE SOVIET UNION'S REACTORS. PART II. POWER REACTORS. Lavrencic, Devana. Com. Naz. Energ. Nucl., Notiz., 15: No. 4, 61-74(Apr. 1969). (In Italian).

The second part of the review of Soviet reactors is devoted to power reactors and discusses the small experimental facilities, the power plants and future prototypes, except fast reactors which will be covered by the third article in this series. Design parameters and schematics of the various systems at the reactors are included. (auth)

33008 ATUCHA NUCLEAR PLANTS IN ARGENTINA. Com. Naz. Energ. Nucl., Notiz., 15: No. 4, 78-81(Apr. 1969). (In Italian).

A picture of Argentina's energy situation and the main characteristics of the Atucha Nuclear Power Plant, scheduled to go into operation around 1975, are included. (auth)

33009 BRIGHT OUTLOOK FOR BRITAIN'S NUCLEAR FUTURE. Evans, R. K. Power, 113: 71-5(June 1969).

The development of nuclear power plants in U.K. is reviewed. Predictions for future power reactor developments are presented. Present power reactor programs are described. (D.C.C.)

33010 ENERGY PICTURE IN HOLLAND: THE DODEWAARD PLANT AND OTHER NUCLEAR PROJECTS. Com. Naz. Energ. Nucl., Notiz., 15: 72-7(May 1969). (In Italian).

A brief review of Holland's present energy picture and its future development is presented. The Dodewaard Power Plant and the plans for another and larger nuclear power plant are described. (auth)

33011 TECHNOLOGICAL DEVELOPMENTS IN 1968 IN JAPAN ATOMIC POWER COMPANY. Yoshioka, Toshio (Japan Atomic Power Co., Tokyo). Dneki Hyoron, 54: 261-8(Jan. 1969). (In Japanese).

The operation and maintenance of the Tokai power station are described. Since passing the preliminary plant-operation inspection in July 1967, preparations had been in progress for the "fuel exchange during the full power operation" test—the formal inspection. But due to a breakage in the CO_2 gas circulator, the inspection could not be carried out. Damages to the inlet bellows of the gas circulator and to the tubes of the heat exchanger are listed. The fuel exchange test and problems in the temperature of fuel elements are discussed. Construction of the Tsuruga atomic power station is described. (NSA of Japan)

33012 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. (comp.). Nucl. Safety, 10: 354-62(July-Aug. 1969).

Regulatory considerations on the following power reactors are summarized: Calvert Cliffs 1 and 2 (Dockets 50-317 and 50-318), Connecticut Yankee (Docket 50-213), Donald C. Cook 1 and 2 (Dockets 50-315 and 50-316), Humboldt Bay (Docket 50-133), Hutchinson Island (Docket 50-335), Indian Point 3 (Docket 50-335), Millstone Point 2 (Docket 50-336), Oyster Creek 2 (Docket 50-320), SEFOR (Docket 50-231), and Three Mile Island 2 (Docket 50-320). Proposed changes to 10 CFR are tabulated; changes relate to: establishment of an Atomic Safety and Licensing Appeal Board, reporting of personnel identification and exposure data, and permission of installation of certain foundations and below-grade walls of power reactor facilities prior to issuance of a construction permit. 12 references. (M.L.S.)

33013 THE PROCEDURES OF NUCLEAR PLANT LICENSING. Albrecht, L.; Schimmel, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie, 12: 77-83(Mar. 1969). (In German).

Licensing procedures and hazard summary report requirements for nuclear power plants are compared for the U.S.S.R., U. S., Hungary, U.K., France, and Germany. Licensing procedure in Germany is described in detail. (D.C.C.)

33014 THE ENERGY OUTLOOK FOR THE UNITED STATES. Gerber, Abraham; Netschert, Bruce C. IEEE (Inst. Elec. Electron. Eng.), Spectrum, 6: No. 6, 38-45(June 1969).

In addition to reporting on prevailing trends in U. S. energy production and consumption, a number of statements concerning the outlook for the future are presented. Although nuclear power is beginning to emerge as a competitor of fossil fuels, it is still too early to predict its eventual impact on the overall picture. 6 references. (auth)

33015 CORPORATE MODEL OF AN ELECTRIC UTILITY. Carlin, J. F. (Boston Edison Co.); Lyons, R. H.; Mitiguy, J. R.; Murphy, E. F.; Galloway, C. D.; Sager, M. A.; Wood, A. J. IEEE (Inst. Elec. Electron. Eng.), Spectrum, 6: No. 6, 75-84(June 1969).

A model of a hypothetical, investor-owned electric utility company is described. The model, which consists of three interrelated digital computer programs—an economic simulation, a cost simulation (based on power generation expenses), and an auxiliary nuclear fuel management program—is designed as a total corporate activities, and certain environmental parameters, are represented by the economic simulation. The production cost simulation is designed to supply fuel cost information to the economic simulation and the fuel management program to supply nuclear fuel scheduling and cost data to both of the other programs. In the corporate model, management—both financial and operative—has a tool by which it is able to quickly assess the effects of one department's action upon another. 10 references. (auth)

33016 ON THE OUTLINE OF THE CONSTRUCTION OF FUKUSHIMA NUCLEAR POWER STATION. Kaburagi, Hiroshi (Tokyo Electric Power Co., Inc.). Hatsuden Suiryoku, No. 98, 75-88(Jan. 1969). (In Japanese).

The configuration and geology of the site and the layout of the plant are shown. The construction of a port with an unloading quay of 170 m length, along which a ship of 3000 ton class can moor, was decided, considering intake of large quantity of cooling water, transport of the heavy cargos, and sending out the used fuel in the future. The construction of two breakwaters in the north and south of the port and the reinforced concrete main building of the power station are described. (NSA of Japan)

33017 CONDITIONS OF LOCATION OF NUCLEAR POWER STATIONS. Itakura, Tetsuro; Moriyama, Fumihiko (Japan Atomic Power Co., Tokyo). Dneki Hyoron, 53: 1471-5(Nov. 1968). (In Japanese).

The criteria for location give the predetermined limits to the building sites on the assumption of discharge of the radioactive substances in case of accidents. The ground, the geological fea-

tures, the water availability, the climatic conditions, the relation to the electric power systems and the means for transportation are considered for the selection. The future measures to solve the location problems were discussed. (NSA of Japan)

Power Reactor Development

33018 (AI-AEC-12765(Vol.1)) 1000 MWe LMFBR (LIQUID METAL FAST BREEDER REACTOR) FOLLOW-ON STUDY. Task I Report. (Atomics International, Canoga Park, Calif.). Nov. 15, 1968. Contract 31-109-38-1996. 139p. (AI-68-Memo-37(Rev.)(Vol.1)). Dep. CFSTI.

For Argonne National Lab., Ill.

A conceptual design is described for a Na-cooled fast mixed-oxide-fueled reactor, its heat transfer and power generation systems, and supporting equipment. The plant characteristics include: steam production in 3 loops at 2400 psig at 900°F with 900°F reheat, modular single-wall shell-and-tube heat exchangers, a turbine-generator plant of conventional design, 4.16 by 7.75 ft cylindrical core, either vented or nonvented fuel elements, and a fuel handling system with a double-rotating plug and in-vessel fuel storage. (H.D.R.)

33019 (AI-AEC-12765(Vol.2)) 1000 MWe LMFBR (LIQUID METAL FAST BREEDER REACTOR) FOLLOW-ON STUDY. Task I Report. (Atomics International, Canoga Park, Calif.). Nov. 12, 1968. Contract 31-109-38-1996. 173p. (AI-68-Memo-37(Rev.)(Vol.2)). Dep. CFSTI.

For Argonne National Lab., Ill.

Technical bases for a 1000 MW(e) LMFBR reference design are presented. The technical bases consist of trade studies for selection of the optimum engineering alternate, core and system parametric studies, materials selection studies, and safety considerations. Economic ground rules used to perform the trade and parametric studies are specified. (H.D.R.)

33020 (BAW-1316(Vol.1)) 1000-MWe LMFBR FOLLOW-ON STUDY. Task I Report. Goulding, B. J. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). June 1967. Contract 31-109-38-1998. 237p. Dep. CFSTI.

For Argonne National Lab., Ill.

The study program will extend the original studies on LMFBR development to include system and component design and parametric evaluations of the nuclear steam supply system and its related systems and subsystems based on an estimation of the state of technology in 1980. The three basic objectives are: (1) develop a reference design; (2) from the reference design, establish research and development program values; and (3) from the reference design, define the National LMFBR development program. Study efforts necessary to achieve these objectives are divided into four tasks, which are briefly described. Task I, which was to develop four basic plant concepts, is complete and a brief summary of each concept is presented. The details of the four concepts are presented in separate reports. Volume 1 evaluates and compares the four concepts and presents a preliminary reference design incorporating the best features of each concept. (H.D.R.)

33021 (BAW-1316(Vol.2)) SYSTEM DESCRIPTION REPORT. Task I, Concept I. 1000-MWe LMFBR Follow-on Study. Boyer, R. L. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Apr. 1967. Contract 39-109-38-1998. 157p. Dep. CFSTI.

For Argonne National Lab., Ill.

The complex of nuclear and turbine islands is designed to produce 1033 MW(e) at a thermal efficiency of 39%; the nuclear plant is a Na-cooled reactor unit that produces 2649 MW(t). Na from the reactor outlet flows upward, exiting at a temperature of 1100°F, and transfers its heat to non-radioactive Na in six intermediate heat exchangers (IHXs). Steam at 1000°F and 1450 psig is generated in three once-through steam generators and flows to a tandem compound, four-flow turbine. Plant design data for this concept are summarized. The primary system arrangement for Concept I is classified as a "pot" or "integral" arrangement; this implies that the system (reactor, pumps, and IHXs) is immersed in a large tank of sodium. The reactor core is a pancake configuration—a cylinder having a low length/diameter ratio, enclosed in a radial and axial blanket. The core fuel pins, each 0.300 in. in outside dia., are arranged in a triangular lattice with a pitch of 0.340 in. The 16-mil, 19-9DL fuel cladding encloses vibratory-compacted (85% dense) UO_2-PuO_2 (12 wt % fissile Pu). Pins in the radial blanket have a 0.497-in. outside dia., are positioned on a 0.517-in. pitch, and are fueled with depleted UO_2. All the principal components—both primary and auxiliary—necessary to reactor operation are housed in a 150-foot spherical reactor containment, which is in turn surrounded by a controlled-leakage building. (auth)

33022 (BAW-1316(Vol.3)) SYSTEM DESCRIPTION REPORT. Task I, Concept II. 1000-MWe LMFBR Follow-on Study. Goulding, B. J. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). June 1967. Contract 39-109-38-1998. 165p. Dep. CFSTI.

For Argonne National Lab., Ill.

The complex of nuclear and turbine islands is designed to produce 1033 MW(e) at a thermal efficiency of 39%; the nuclear plant is a Na-cooled reactor unit that produces 2649 MW(t). Na from the reactor outlet flows upward, exiting at a temperature of 1100°F, and transfers its heat to non-radioactive Na in six intermediate heat exchangers (IHXs). Steam at 1450 psig and 1000°F is generated in three once-through steam generators and flows to a 1000-MW(e) tandem compound turbine. The primary system arrangement of Concept II is classified as a "spread-out combined plant" arrangement; this implies that the reactor is separated from the primary Na pump and IHX combination and is connected by straight-line, coaxial pipework. This design results in a compact reactor design, since the pump/IHX combinations are located radially around the reactor and immediately beyond the reactor biological shield in pits. Other advantages of this design—compared with the integral arrangement of Concept I—are reduction of Na inventory, shop-built core pressure vessel, and the extremely short length of primary pipework. Disadvantages include problems of thermal expansion associated with the pipework and thermal shock on the core vessel due to the smaller Na capacity. The reactor core is a cylindrical configuration having a length/diameter (L/D) ratio of 0.34, enclosed in radial and axial blankets. The core fuel pins, each 0.275 in. in outside dia., are arranged on a triangular lattice pitch spacing of 0.340 in. The 16-mil, 19-9DL fuel cladding encloses vibratory-compacted (85% dense) UO_2-PuO_2. Pins in the radial blanket have a 0.497-inch outside diameter, are spaced on a 0.517-inch triangular pitch, and are fueled with depleted UO_2. All principal primary and auxiliary components required for reactor operations are housed in a cylindrical containment 150 feet in diameter; it has semi-elliptical ends and is surrounded by a controlled-leakage building. (auth)

32023 (BAW-1316(Vol.4)) SYSTEM DESCRIPTION REPORT. Task I, Concept III. 1000-MWe LMFBR Follow-on Study. Goulding, B. J. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). July 1967. Contract 39-109-38-1998. 162p. Dep. CFSTI.

For Argonne National Lab., Ill.

The nuclear island and turbine island complex is designed to produce 1042 MW(e) at a thermal efficiency of 43%. This plant consists of a Na-cooled reactor unit that produces 2415 MW(t). The reactor outlet Na flows upward and exits at a temperature of 1150°F; it transfers heat to non-radioactive Na via three intermediate heat exchangers (IHXs). Steam at 2400 psig and 1000°F is generated in three once-through steam generators and flows to a cross compound, four-flow turbine. Three Na reheaters raise the temperature of the exhaust steam from the high-pressure turbine to 1000°F before it enters the low-pressure turbine. The primary system for Concept III is classified as "spread-out" with a "hot cell" unit for refueling; this concept has six pumps and three IHXs divided into loops wherein two pumps in parallel feed each heat exchanger. This results in a clear and unobstructed charge face around the hot cell, with just the three groups of two pumps spaced at 120 degrees standing above the charge face floor. Other advantages and disadvantages of this design are compared with the integral pot design. The reactor core configuration is annular and has an outside equivalent dia. of 108.37 in. and an inside equivalent dia. of 44.75 in. The core is surrounded by an inner, outer, and axial blanket; its active length is 36.8 in. The core fuel pins are 0.250 in. dia. and are arranged on a triangular lattice with a pitch spacing of 0.297 in. The cladding, 10-mil SS 304, contains vibratory-compacted, 85% dense, enriched UO_2-PuO_2. The 0.534 in. dia. radial blanket pins are spaced on a 0.564-inch triangular pitch and are fueled with depleted UO_2. All primary and auxiliary components necessary for reactor operations are housed in a cylindrical reactor containment 155 ft in dia. (auth)

33024 (BAW-1316(Vol.5)) SYSTEM DESCRIPTION REPORT. Task I, Concept IV. 1000-MWe LMFBR Follow-on Study. Goulding, B. J. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Aug. 1967. Contract 39-109-38-1998. 174p. Dep. CFSTI.

For Argonne National Lab., Ill.

The complex of nuclear and turbine islands is designed to pro-

duce 1039 MW(e) at a thermal efficiency of 43%; the nuclear plant is a Na cooled reactor unit that produces 2416 MW(t). Na from the reactor outlet flows upward, exiting at a temperature of 1150°F, and transfers its heat to non-radioactive Na in six intermediate heat exchangers (IXHs). Steam at 2400 psig and 1000°F is generated in three once-through steam generators and flows to a cross compound, four-flow turbine. Three Na reheaters raise the temperature of the exhaust steam from the high-pressure turbine to 1000°F before it enters the low-pressure turbine. Plant design data for this concept are summarized. The primary system for Concept IV is an "integral pot" arrangement with an under-the-plug refueling scheme. Six tandem pump/IHX assemblies are submerged in the Na pool (the pump motors are placed at the charge face level). These assemblies are arranged in two groups of three, radially located from the center of the core between the core vessel and the reactor vessel. This arrangement results in a compact building, and all of the equipment can be serviced by the main overhead rotary crane. Some advantages and disadvantages of the integral pot design are compared with "spread-out" design. The reactor core is a pancake configuration—a cylinder having a L/D ratio of 0.235 and an outside dia. of 113.8 in.; it is enclosed in a radial and axial blanket. The core active length is 60.8 in. The core fuel pins, each 0.300 in. in outside dia., are arranged in a triangular lattice with a pitch of 0.330 in. The 10-mil, SS 304 fuel cladding encloses vibratory-compacted (85% dense), enriched UO_2–PuO_2. The pins in the radial blanket have a 0.472-in. outside diameter, are positioned on a 0.502-in. pitch, and are fueled with depleted UO_2. All the principal components—both primary and auxiliary—necessary to reactor operation are housed in a 110-foot cylindrical reactor containment. 5 references. (auth)

33025 (CEND–322) PRELIMINARY STUDIES FOR A REFERENCE CONCEPTUAL DESIGN OF A 1000 MWe LMFBR. 1000 MWe LMFBR Follow-on Study. Task I Report. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). 1967. Contract 31-109-38-1999. 265p. Dep. CFSTI.

For Argonne National Lab., Ill.

The scope of the work on the 1000 MW(e) LMFBR development is in the area of the heat generation system of the nuclear steam supply system. The objective of the study on the heat generation system is to identify the research and development programs which are required to achieve the selected design by 1980. Conceptual system design descriptions were prepared and evaluated to establish the concept which merits detailed study. The conceptual systems studies are reviewed and the selected reference system is described. A cylindrical reactor with a small length/diameter ratio (two-foot seed height) was selected based on parametric surveys of both modular and cylindrical designs. Preliminary conceptual design descriptions were prepared for the heat generation system and four major subsystems. The results of the trade-off study made to permit a choice between an under-the-plug and an open cell refueling system are presented. 30 references. (H.D.R.)

33026 (EUR–4209) OPTIONS FOR A 250 MWe ORGEL PROTOTYPE PLANT ORIENTATION STUDY. Decressin, A.; Lafontaine, F.; Noailly, J.; Tauch, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 14, 1969. 50p. Dep.

A comparison is made for three different ORGEL power plants of 250 MW(e) gross, in order to illustrate different possibilities of this string. One plant is working on natural U, two other plants on slightly enriched U. Fuel is always UC, the organic coolant is of the OM-2 type. The fuel management foreseen is a bidirectional one with the reactor being on-load. The three reactors have been optimized taking into account a certain number of technological restrictions which are due to the actual state of development of the ORGEL string. The characteristics of the three plants are given and discussed in detail as well as the hypothesis adopted for the calculations. 17 references. (auth)

33027 (GEAP–5618) COMPARISON OF TWO SODIUM-COOLED, 1000 MWe FAST REACTOR CONCEPTS. Task I. 1000 MWe LMFBR Follow-On Work. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). June 1968. Contract 31-109-38-1997. 370p. Dep. CFSTI.

For Argonne National Lab., Ill.

The results of a comparison of two different concepts for a 1000 MW(e) LMFBR are presented to provide the cost incentives for the design alternates and to consider these cost incentives against the development required to achieve the implied state of technology. Included are the major analysis methods, background data, and the reasons for the selection of important parameters. The reference concept selected is described. 59 references. (H.D.R.)

33028 (WARD–2000–20) MOISTURE SEPARATION OR STEAM REHEAT VS SODIUM REHEAT PLANT CYCLE TECHNICAL AND ECONOMIC EVALUATION. 1000 MWe LMFBR Follow-on Study. Keyfitz, I. M. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr. 1968; Reissued Jan. 1969. Contract 31-109-38-200. 58p. Dep. CFSTI.

For Argonne National Lab., Ill.

An evaluation of a moisture separation or steam reheat cycle versus a Na reheat cycle for a nominal 1000-MW(e) Na-cooled, fast breeder reactor verifies that, from both a technical and economic viewpoint, moisture separation or steam reheat is superior to Na reheat. The economic advantage is estimated at from 0.014 to 0.06 mills/kWh power cost, depending upon the assumed total capital price in the range of 120 to 160 $/kW and the assumed fuel cost in the range of 7 to 16 cents per million Btu. Expenses incurred by the customer are not included in the total capital price. 5 references. (auth)

33029 (WARD–2000–33) 1000-MWe FAST BREEDER REACTOR FOLLOW-ON STUDY. Task I Final Report. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). June 1968; Revised Jan. 1969. Contract 31-109-38-2000. 676p. Dep. CFSTI.

For Argonne National Lab., Ill.

Conceptual design studies are reported for a 1000-MW(e) liquid metal fast breeder reactor. Technical and economic comparisons, or trade-off studies, lead to a choice of: a four-module core, fuel vented to coolant, combined hot-cell refueling and containment, two heat-removal loops, a piped primary system, and a non-reheat steam cycle. Also discussed are fuel and materials selection, sodium properties, fuel element design, and preliminary design-basis accident analyses. The resultant composite of all of these design selections is referred to as the Task I Reference Design, which forms the basis for the design of an integrated plant to be performed subsequently in Task II. 165 references. (auth)

33030 (WASH–1089) EVALUATION OF GAS-COOLED FAST REACTOR. (Oak Ridge National Lab., Tenn.). Apr. 1969. 241p. Dep. CFSTI.

The technical feasibility, physics performance, and economics of gas-cooled fast breeder reactors that might be included in the AEC reactor development program are evaluated. Topics discussed include: gas-cooled fast breeder reactor designs; physics evaluation; engineering evaluation of gas-cooled fast breeder reactor core; engineering review of plant design; review of plant safety features; costs; and research and development program. 54 references. (D.C.C.)

33031 MOLTEN SALT REACTORS. Haubenreich, P. N.; Rosenthal, M. W. (Oak Ridge National Lab., Tenn.). Sci. J., 5: 41-7 (June 1969).

New types of reactors, able to use nuclear fuel more fully, need to be developed if increasing power demands are to be met economically. One promising concept is a type of breeder in which the fuel is carried in molten salt. (auth) (UK)

33032 USSR'S REACTORS. Lavrencic, Devana. Com. Naz. Energ. Nucl., Notiz., 15: 51-65(May 1969). (In Italian).

A review is made of the various types of fast reactors developed by the USSR since 1955, with considerations concerning the future prospects of this type of reactors in the nation's nuclear program. 10 references. (auth)

33033 DEVELOPMENT OF ADVANCED THERMAL REACTOR. Unoki, Takeo Denryoku Shinpo, 14: No. 12, 38-43 (Dec. 1968). (In Japanese).

For the domestic development of power reactors, a fast breeder reactor and an advanced thermal reactor (converter) were adopted as a national project. The Advanced Thermal Reactor, D_2O moderated and boiling light-water cooled, with electric output 200,000 kW, has the advantages for Japan: relatively small consumption of nuclear fuels, the operation with supply of natural uranium, and early achievement of the high economy. The development of the Advanced Thermal Reactor is described in the following: the present state of development of power reactors; the need for development of the ATR; the past and present of its development; an outline of the ATR prototype; preliminary survey of the construction site, and the procedure of construction. (NSA of Japan)

Kinetics and Dynamics

33034 (EUR–4250) REFLOS: CODE FOR THE REFINED EVALUATION OF FUEL LOADING SCHEMES. Boettcher, W.; Schmidt, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Feb. 7, 1969. 131p. Dep.

REFLOS represents a code for the refined evaluation of fuel loading schemes in heavy water moderated reactors or, more generally, in reactors with weakly absorbing moderator. Its scope is to determine reactivity behavior, power-distribution, attainable burn-up and fuel cycle cost for both the running-in period and the equilibrium of a power reactor. REFLOS has been written in FORTRAN 4 for the IBM 360/65 computer. A survey about the methods applied in the individual subroutines of REFLOS, a detailed description of the input parameters, and an example for input and output are presented. 9 references. (auth)

33035 (EUR-4254) ORGEL DYNAMICS. Balz, W.; Bona, C.; Decressin, A.; D'Hoof, H.; Lafontaine, F.; Noailly, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center. European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). Jan. 3, 1969. 274p. Dep.

The heat exchanger attached to the reactor is a drum boiler. The mathematic model of simulating the power plant is explained. The heat exchanger investigated is of the Benson type. (auth)

33036 (EURFNR-609) NUCLEAR CHARACTERISTICS OF HELIUM-COOLED FAST REACTORS. Eisemann, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translated from report KFK-864. 23p. (EUR-4155). Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The nuclear characteristics of nine He-cooled fast breeder reactors with a core power of 2500 MW(t) are analyzed and compared. The main difference in the reactors is the type of cladding material. Reactors with V-alloy fuel rods, reactors with chrome-cermet core, and reactors with graphite-coated particles were considered. The nuclear calculations were based on the Russian ABN group set. 4 references. (D.C.C.)

33037 (EURFNR-625) ANALYSIS OF FAST CRITICAL ASSEMBLIES AND LARGE FAST POWER REACTORS WITH GROUP-CONSTANT SETS RECENTLY EVALUATED AT KARLSRUHE. Kusters, H.; Schmidt, J. J.; Broeders, C. H. M.; Eisemann, E.; Metzenroth, M.; Schroeter, K. E.; Thiem, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Nov. 1968. 73p. (KFK-793; EUR-3962; EANDC(E)-113). Dep.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The basic data of heavy isotopes from KFK-SNEAK, KFK 26-10, and ABN group sets are compared. Uncertainties of these data groups are described. Analysis of a series of critical and subcritical assemblies is presented to evaluate the quality of the group constant sets. The influence of the various data sets on the prediction of neutronic behavior of large fast power breeder reactors with He, Na, and steam coolants is analyzed. 104 references. (D.C.C.)

33038 (GA-9166) GALAHAD: CODE FOR OPTIMIZING CONTROL OF XENON TRANSIENTS WITH DYNAMIC PROGRAMMING. Neef, William I. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 7, 1969. Contract AT(04-3)-167. 83p. Dep. CFSTI.

GALAHAD uses a 2 group, X-Y representation of a reactor to calculate the equilibrium Xe concentration at each mesh point. Following equilibration and after a spatial Xe transient is initiated, GALAHAD determines the effects of several strategies which can be used to control the transient and picks the best strategy for each time interval during the transient. The time during which one strategy must be used is a decision interval. The GALAHAD code divides the period following the transient into 4 decision intervals. There are 6 allowable strategies for each decision interval. The program is written in FORTRAN 5 for the UNIVAC 1108. 4 references. (auth)

33039 (KR-133) FROST: TWO-DIMENSIONAL FEW GROUP NEUTRON DIFFUSION CODE. Andrzejewski, K. (Institutt for Atomenergi, Kjeller (Norway)). Feb. 1969. 28p. Dep.

A complete description of the few-group, two-dimensional diffusion theory code FROST, coded in FORTRAN 63 for the CD 3600 computer, is presented. The difference equations in FROST are in usual form, but the numerical method for solving them is referred to as reconditioning method. FROST is designed for diffusion theory calculations of BWR square fuel assemblies in 5 energy groups. More than one thermal group is permitted. The FROST input and output are made as similar to TWENTY GRAND's as possible. 3 references. (auth)

33040 (ORNL-tr-2115) KINF: A PROGRAM FOR TWO-DIMENSIONAL REACTOR CELL CALCULATIONS BY THE MONTE CARLO METHOD. Marti, J. ([Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)]). Translated for Oak Ridge National Lab., Tenn., from report EIR-140. 45p. Dep. CFSTI.

The KINF Monte Carlo program was developed for a determination of neutron density distribution in two-dimensional reactor cells. The entire energy spectrum of 0 to 10 MeV is taken into account. The geometry routine calculates the position and zone where the next collision takes place as well as the partial paths covered in each zone with a given starting point in any zone of the reactor cell and a given projectory in these path lengths. 29 references. (D.C.C.)

33041 (RT/FI-(69)1) EDEN AND EDEN* CODES FOR HETEROGENEITY CALCULATION IN FAST REACTORS. Bitelli, G.; Dal Bono, I.; Leproni, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 12p. (PRV-r-(68)26). Dep.

The EDEN and EDEN* codes give the fine structure of the real and adjoint flux in lattices of fast reactors and the reactivity variation due to heterogeneity effects. The programs are written in FORTRAN 2 for IBM 7094. (3 references) (auth)

33042 (RT/FI-(69)8) THE CRAC CODE (COUPLED REACTOR ANALYSIS CODE). Salvatores, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 10p. (PRV-r-(68)23). Dep.

The CRAC code calculates real and adjoint fluxes and K_{ij} and l_{ij} coupling parameters according to Avery's theory for coupled reactors, as well as generalized sources to be used in perturbation analysis of coupled systems. The program is written in FORTRAN 2 for IBM 7094. (5 references) (auth)

33043 STATICS OF THE POWER FAST BREEDER REACTOR WITH THE CENTRAL BLANKET. Ikeda, Nagayasu; Hara, Hideki (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 83, 39-56(Mar. 1968).

The thermal characteristics and the simple nuclear performance of the fast breeder reactor (FBR) with the central blanket were examined, using the two-dimensional neutron flux distribution. The neutron flux distribution in the FBR reactor with the central blanket was obtained by the two-dimensional calculation with the aid of the double series expansion method, and this distribution was different from the sinusoidal distribution which is often used in the one-dimensional calculation. The axial distribution of the fuel central temperature of the core with a central blanket is more flat than that of a usual core without the central blanket. This flattening causes decrease of the maximum temperature of fuel about 150°C, and therefore is useful for the design. The increment of the central blanket radii causes the increase of enrichment, and neutrons leak not only into the usual outer blanket, but also into the central blanket and therefore the breeding ratio increases. Consequently, in the central blanket type reactor, the critical volume of the core increases without lowering the fuel enrichment, and the design of large power FBR without decreasing the breeding ratio is possible. (NSA of Japan)

33044 ON THE DYNAMIC BEHAVIORS OF NATURAL CIRCULATING BWR. Takahashi, Ryoichi; Kobayashi, Nobutake (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 83, 57-74(Mar. 1968).

Oscillatory phenomena of SPERT and BORAX were investigated from a view point of the space dependent kinetics. The diffusion equation and the nodal technique were used for the numerical solution. In order to describe the thermohydraulic system, the differential forms of the conservation laws of mass, energy, and momentum were taken into account. The heat transfer coefficient, the slip ratio, and the multiplier for two phase friction loss, that cannot be derived by the theoretical consideration, were represented by the experimental formulae so that the feed back model can be more accurately described. The dynamic behaviors of the system were determined by solving the initial-boundary problem, taking into account the essential disturbances such as the feed water flow rate, the inlet temperature, and the inserted reactivity. The instability of the two phase flow is not the simple feed back phenomenon which can be characterized by the inherent time delays of the system as cited in the automatic control theory since the time constant can not be defined and depends on time and the place. It was concluded from the simulation of SPERT core that the amplitude of the power oscillation becomes larger than the sinusoidal power distribution, and its frequency is 1.5 cps. (NSA of Japan)

Shielding

33045 (AEC-tr-6879) PHYSICS OF REACTOR SHIELDING. Kazanskii, Yu. A.; Kukhtevich, V. I.; Matusevich, E. S.; Sinitsyn, B. I.; Tsypin, S. G. Translation of Fizicheskye Issledovaniya Zashchity Reaktorov, Moscow, Atomidat, 1966. 359p. (TT-68-50324; IPST-Cat.-5138). Dep. CFSTI.

The detailed characteristics of the complete radiation spectrum within and at the boundary of biological shields are examined. The empirical data necessary for design of reactor shields are analyzed and generalized. The spatial, energy, and angular distributions of γ radiation and neutrons in the shield, the formation and methods for the attenuation of captured γ radiation, and the scattering of γ quanta and neutrons in air and by the shield are examined. The experimental and calculated data are compared. The device and installations available for the investigation of the shield are described and methods for obtaining experimental data are reported. (tr-auth)

Cooling Systems

33046 (AECL-3183) THE DETERMINATION OF VAPOUR PRESSURES OF ORGANIC LIQUID REACTOR COOLANTS AT ELEVATED TEMPERATURES. Stewart, R. B.; Smith, G. G. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Nov. 1968. 22p. Dep. CFSTI. CAN $1.00.

A method is described for the high temperature measurement of the vapor pressures of polyphenyl-base reactor coolants. It is widely applicable to other organic and aqueous liquid samples and can be used at temperatures up to 500°C and at pressures up to 500 psia. Two variations of the technique are described. One uses a fixed volume sample cell, applicable to single component measurements, and the other a cell with a very small controlled void volume, applicable to multi-component mixtures. Accuracies are to within ±1 psia. Sample size is about 2.5 ml. Data may be taken manually or by recorded scans. Corrections can be made for pressure increases due to pyrolytic decomposition of the organic liquid at high temperatures. Samples may be laboratory loaded or sampled in closed vessels under in-system conditions. (auth)

33047 (APED-5460) DESIGN AND PERFORMANCE OF GENERAL ELECTRIC BOILING WATER REACTOR JET PUMPS. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 1968. 88p. (68-APE-15). Dep. CFSTI.

Design parameters and operational characteristics of jet pumps are described. A review of the development and testing program is presented. Performance data for jet pumps under steady state, transient, and accident responses are included. (D.C.C.)

33048 (UNC-5226) CARBON METER FOR SODIUM. Final Report. Caplinger, W. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Mar. 1969. Contract AT-(30-1)-3665. 194p. Dep. CFSTI.

A meter was developed which continuously measures a quantity related to the carburizing potential of Na. It operates by diffusing C from the Na through a sensing diaphragm into a decarburizing gas. The diaphragm is in the form of a thin (0.010-in.) iron tube, about $\frac{3}{8}$-in. diameter, immersed in the Na stream at 1400°F. The decarburizing gas of moist Ar and H_2 sweeps over the inside of the Fe tube, reacts with the C, and carries it to a flame ionization detector for analysis. Conditions are so arranged that the C content of the gas is a continuous measure of the C activity of the Na. The sensor measures a wide range of carburizing potentials from that of clean Type-304 stainless steel to an activity corresponding to the saturation of alpha iron by carbon. The complete instrument package includes a carbon meter sensor, a side loop with heaters to allow the sensor to be installed in systems operating at less than 1400°F, a temperature controlling console for the side loop, and a console for analyzing the decarburizing gas. These components are rugged and reliable, and are capable of continuous automatic operation. Overtemperature protection and recorders for the carbon level and side loop temperatures are included. Four kinds of Na testing apparatus were used to develop the meter. Basic sensor parameters were chosen from test results in static pots. Carburizing effectiveness of various carbon sources was determined from small sealed Na-filled capsules. Response time, stability, and reproducibility were investigated in thermal convection loops. Tests of the prototypical field test instrument package were investigated in a pumped loop at UNC. 19 references. (auth)

33049 DEVELOPMENT OF CATALYTIC RECOMBINER FOR BOILING WATER REACTOR. Murata, Toshifumi; Yusa, Hideo (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron, 50: No. 12, 7-10(Dec. 1968). (In Japanese).

Oxygen and hydrogen gas mixture as a reaction gas and nitrogen gas or water vapor as a dilution gas were introduced under various conditions of flow rate, mixing ratio, and temperature to a catalyzer-packed-layer. By measuring gas-chromatographically the hydrogen concentration at the inlet and outlet of the layer, the reaction rate of recombination between oxygen and hydrogen was examined. The most suitable conditions for operating and designing the recombiner can be selected as follows. The optimum inlet hydrogen concentration is about 2%; smaller concentration is uneconomical, while a larger one makes catalyzer activity lower. Inlet gas flow of 10^3 kg/m^2 mass velocity and 0.5 m/s linear velocity is adequate. Since water inflow to treated gas is unfavorable, the suitable inlet gas temperature is 110 to 130°C. When the length of packed layer is long, it is uneconomical, so that the length of about 10 cm is sufficient. As catalyzers, four kinds of alumina-bearing-palladium catalyzer were compared. J-K catalyzer is most excellent among catalyzers made in Japan. When a catalyzer is used for a very long time, the temperature of packed-layer may rise enormously by chance and the catalyzer may be oxidized or sintered, resulting in a decrease of its efficiency. Oxidized catalyzer can be easily reduced by hydrogen gas heated at about 100°C, and in case of sintering, after oxidizing the catalyzer by air of about 400°C, reduction is undertaken to regenerate it. (NSA of Japan)

Fuels

Refer also to abstract 32048.

33050 (DUN-SA-72) INCENTIVES FOR THORIUM-URANIUM CROSSED PROGENY FUELING FOR BREEDER-CONVERTER REACTOR SYSTEMS. Lang, L. W. (Douglas United Nuclear, Inc., Richland, Wash.). July 10, 1968. 6p. (CONF-690211-1). Dep. CFSTI.

From American Nuclear Society Meeting, Washington, D. C.

The incentives for crossed-progeny fueling are evaluated for three reactor systems which were considered to meet a projected power demand from 1980 to 2030. Total U_3O_8 costs and separative work costs are used as measures of merit for (1) normally fueled light water reactors (LWR's) and fast oxide breeders, (2) crossed-progeny mode using ^{233}U from thorium-blanketed fast reactors to fuel hardened-spectra LWR's, and (3) crossed-progeny mode using ^{233}U from thorium-blanketed fast reactors to fuel Pu-producing molten salt reactors. (H.D.R.)

33051 (EUR-4251) ORIENTATION STUDY ON THE ECONOMIC POTENTIAL OF AN ORGEL POWER PLANT EQUIPPED WITH A G-30 FUEL ELEMENT. Balz, W.; Chambaud, B.; Realini, GC.; Tauch, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 20, 1969. 18p. Dep.

The organic liquid cooled and heavy water moderated ORGEL type reactor is fuelled with slightly enriched UC elements consisting of bundles of 18 SAP-clad rods. The economic potential of such an ORGEL Prototype plant being alternatively equipped with a further subdivided UC fuel element consisting of bundles of 30 SAP-clad fuel rods is analyzed. This element is designed to fit into the pressure tubes of the reference plant reactor core. The fuel is submitted to radial shuffling only, fuel replacement being done on-load. 5 references. (auth)

33052 (EURFNR-607) TEMPERATURE AND STRESS DISTRIBUTIONS IN FUEL ROD CLADS WITH SPIRAL SPACERS FOR STEAM-COOLED FAST BREEDERS. Hoofmann, H.; Rust, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Translation of report KFK-805. 80p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The temperature distributions and stresses in spiral-spacer clads are mainly influenced by the spacer geometry, the local heat transfer conditions, and operating conditions. The tubes were still more strongly stressed in the immediate vicinity of spacers than cylindrical tubes. The number of fins is of subsidiary importance in establishment of maximum temperatures. However, 6 fins per rod give slightly smaller reference stresses than 3 fins. Results of various testing conditions and configurations are presented. 11 references. (auth)

33053 (GAMD-7535(Rev.)) FREVAP-8 FORMULATION FOR ESTIMATING THE RELEASE OF METALLIC FISSION PRODUCTS FROM HTGR FUEL ELEMENTS. Zumwalt, L. R. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 24, 1967. Contract AT(04-3)-633. 34p. Dep. CFSTI.

A fission product release model for formulating a digital computer code for two absorber regions taking into account multicomponent sorption behavior and assuming steady-state diffusion is presented. Included is an index necessary for the treatment of the effect of the competition of various chemical species for sorption sites in graphite or amorphous carbon. (H.D.R.)

33054 (WARD-2000-31) EVALUATION OF VENTED-TO-COOLANT DESIGN FOR SODIUM-BONDED CARBIDE FUEL RODS. 1000 MWe LMFBR Follow-on Study. Lipps, A. J. Jr. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Feb. 1968. Contract 31-109-38-2000. 56p. Dep. CFSTI.

For Argonne National Lab., Ill.

A scoping study was undertaken to assess the feasibility of venting Na-bonded mixed (U,Pu)C fuel elements. The venting-to-coolant concept, because of its more direct approach, was the venting concept selected for a comparison with a nonvented design. The pertinent fuel rod parameters for the designs considered are summarized. Although there is some cost incentive for venting, the preliminary cost difference appears to be small and is not the deciding factor. The cost advantage of the vented concept is due primarily to the effect of the shorter overall height of the fuel rod and the resulting shorter related plant equipment. If a vented rod could operate with a thinner cladding, the lower fuel cycle cost would enhance the operating cost advantage of the vented concept. The safety considerations may be the deciding factor in evaluating vented versus nonvented fuel concepts. The major safety problem in a vented design is the entrainment of the fission gas in the coolant. This problem can be eliminated by placing surge tanks in the primary loop. The major problems in the nonvented rod are the loss of the Na bond in the event of a pinhole failure in the cladding and gas blanketing of the fuel assembly. These problems are connected with the large volume of high-pressure gas contained in the rod, which is a characteristic of the nonvented design. At high burnup, the nonvented rod may also be more prone to fuel rod failures. The large quantity of radioactive gas is also a potential hazard in fuel handling. 8 references. (auth)

33055 MODEL STUDIES FOR THE DEVELOPMENT OF A NUCLEAR POWER SYSTEM USING FAST BREEDER REACTORS. Wenzel, P. (Institut fuer Kraftwerke, Berlin). Kernenergie, 12: 84-7(Mar. 1969). (In German).

The development of a nuclear power system operated by fast reactors with initial linear rise of doubling time and then stabilized doubling time is described by a simple analytical model for the case of shortened doubling time in fast reactors. The period and volume are determined in which optimum additions of external fissile material are necessary. 5 references. (auth)

33056 INVESTIGATIONS ON THE MOVEMENT OF FUEL ELEMENTS IN THE CORE OF A PEBBLE BED REACTOR. Bedenig, D.; von der Decken, C. B.; Rausch, W. (Brown Boveri/Krupp Reaktorbau GmbH, Juelich, Ger.). J. Eng. Ind., 91: 390-4(May 1969).

For several years gas-cooled high temperature reactors have been developed in Germany, the main feature of which are their pebble-type fuel elements. The pebble bed is in the state of a continuous circulation process which is the reason for a series of nuclear and technical advantages. To make use of these advantages, comprehensive experimental studies on the flow behavior of a pebble bed were carried out. Experimental equipment and the most successful method of measurement are described. Typical results of parameter studies are reported as well as a theoretical model to calculate the pebble bed flow behavior. Typical functions describing the flow behavior in the core of the THTR 300 MW_e Prototype Reactor are reported. 8 references. (auth)

Operation and Economics

33057 (GA-9360) 40-MW(e) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending April 30, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). May 29, 1969. Contract AT-(04-3)-314. 59p. Dep. CFSTI.

KRYPTON ISOTOPES Kr-85— content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
KRYPTON ISOTOPES Kr-87— content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
KRYPTON ISOTOPES Kr-88— content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
KRYPTON ISOTOPES Kr-89— content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
NEUTRONS, FAST— effects on dimensional changes in Peach Bottom Power Reactor Unit 1 fuel elements
PEACH BOTTOM POWER REACTOR, UNIT 1— operations during January to April 1969
— fuel element failure in, effects of dimensional changes on
— coolant of, effect of power level on content of krypton isotopes in
REACTOR CONTROL ELEMENTS— reactivity worth of Peach Bottom Power Reactor Unit 1, calibration of
REACTOR FUEL ELEMENTS— failure of Peach Bottom Power Reactor Unit 1, effects of dimensional changes on
— radiation effects on dimensional changes in Peach Bottom Power Reactor Unit 1, measurement of fast neutron
STRONTIUM ISOTOPES Sr-90— content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
XENON ISOTOPES Xe-135— content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
XENON ISOTOPES Xe-138— content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on (D.C.C.)

33058 (WASH-1126) COST-BENEFIT ANALYSIS OF THE U.S. BREEDER REACTOR PROGRAM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr. 1969. 98p. Dep. GPO $1.00.

An examination of the cost-benefit for a number of postulated cases that include the currently planned breeder development program is presented. Included is a discussion of the assumptions which provide the basic framework for the postulated cases. The results of the cost-benefit analysis depend upon assumptions which can substantially affect the future cost of electricity. The changes in the following key variables are examined: timing of the introduction date of the breeder; uranium costs; fossil fuel costs; electricity demands; energy costs; and discount rates. (auth)

33059 MOLTEN-SALT REACTOR PROGRESS. Haubenreich, P. N. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Int., 5p. (Apr. 1969).

Design parameters for the MSRE are listed. Operating experiences with the MSRE are reviewed. (D.C.C.)

Safety and Siting

33060 (AEC-tr-7047) STUDIES ON LOSS OF COOLANT ACCIDENT IN WATER COOLED NUCLEAR POWER REACTORS. PART II. Takekoshi, Tadasu; Nakata, Seibei; Nishiwaki, Ichiro; Shimizu, Sadaaki; Inami, Kuniaki; Kasuga, Yasuhiro. Translated from Denki Shikensho Iho, 32: 975-99(1968). 49p. Dep. CFSTI.

A blowdown test section simulating a double ended pipe rupture has been set up in the PWR loop to develop information on the blowdown phenomena associated with a loss-of-coolant accident in water-cooled power reactors. Provisions simulating a double ended break are located close to the coolant inlet of the reactor vessel, and instrumentations are included to measure the transient behavior of the coolant on the pressure and mean density in the reactor vessel, on the pressure drop between the vessel and the break point, and on the critical pressure at the break point. Parametric blowdown tests have been performed to evaluate the effect of the rupture mode on the rate of change of void fraction and coolant pressure during the blowdown. Blowdown code based on a phase-separation model has been developed successfully to analyze the features of double ended break. The major conclusions are as follows. The experimental and analytical results show that there exists a marked influence of phase separation on the blowdown phenomena in the case of double ended break, and that the rate of change of void fraction takes a similar order of magnitude as compared with a single ended blowdown from the break point close to the coolant inlet of the reactor vessel. The flow resistance of the primary circuit during the blowdown is closely coupled with the rupture area of the break point, and computed results of the critical pressure based on a homogeneous model shows good agreement with experimental ones. (auth)

33061 (BMI-1863) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS: DEPOSITION ON PRIMARY-SYSTEM SURFACES. One of Three Separate Final Reports on Task 3. Genco, Joseph M.; Berry, Warren E.; Rosenberg, Harvey S.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Mar. 1969. Contract W-7405-eng-92. 60p. (EURAEC-2105). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Iodine deposition on prefilmed Zircaloy and stainless steel sur-

faces and Te deposition and desorption on bare and prefilmed Zircaloy surfaces were studied as related to fission-product behavior in the primary vessel during a loss-of-coolant accident in a water-cooled reactor. I_2 deposition experiments were conducted with I_2-air-steam and HI-hydrogen-steam over the temperature range 150 to 750°C. Te deposition and desorption experiments were conducted at 200 to 500°C. I_2 deposition rates were extremely low and decreased with increasing temperature according to an Arrhenius relationship. Rate coefficients of the order of 10^{-2} to 10^{-3} cm per sec for HI and 10^{-3} to 10^{-5} cm per sec for I_2 were determined over the temperature range 150 to 750°C. The deposition coefficients for I_2 were first order while those for HI exhibited a dependency upon square root of time and square root of HI concentration. Because of the corrosive action of I_2, deposition was greater on bare metal surfaces than on prefilmed surfaces, and any effects of stress on I_2 deposition were limited to the extent that the oxide film was cracked and bare metal was exposed. Application of the experimental deposition data to loss-of-coolant accident conditions indicates that little I_2 or HI would be deposited on primary-system surfaces. Prefilmed and bare Zircaloy reacted with Te vapor at and above 400°C to form an apparent Zr_2Te_3. Less than 20% of the deposited Te was desorbed during 49 hr of exposure at 400°C under continuous evacuation. (auth)

33062 (BMI-X-10244) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, July–September 1968. Genco, Joseph M.; Rosenberg, Harvey S.; Berry, David A.; Cremeans, George E.; Berry, Warren E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1968. Contract W-7405-eng-92. 26p. (EURAEC-2073). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Tellurium deposition experiments were continued using Zircaloy-4 specimens. Elemental iodine deposition experiments were performed under condensing steam conditions using commercial containment-vessel coatings. Rates of I_2 desorption caused by condensate washdown of commercial coatings are tabulated. Development continued on a reactive paint for use as a passive safety system. Methyl iodide sorption data for various coatings in steam-air environments are reported. Coating pigmentation studies were continued, and coating resistance to steam at 150°C was measured. (H.D.R.)

33063 (BMI-X-10252) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, September–December 1968. Genco, Joseph M.; Rosenberg, Harvey S.; Berry, David A.; Cremeans, George E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1969. Contract W-7405-eng-92. 18p. Dep. CFSTI.

Work continued on construction of a mathematical model for describing the I_2 deposition process on painted surfaces under condensing steam conditions. Loss of coolant accident environmental test results are reported for I_2 and methyl iodide deposition on coating candidates. Loss of I_2 and CH_3I after desorption from coatings by 170°C flowing He is tabulated. (H.D.R.)

33064 (DUN-SA-83) CONSERVATISM IN EARTHQUAKE DESIGN CRITERIA. Davis, Harold S. (Douglas United Nuclear, Ind., Richland, Wash.). Jan. 17, 1969. 4p. (CONF-690609-1). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

The critical components of a nuclear reactor are designed to resist a particular level of earthquake intensity. A structure or component can withstand greater shocks, depending upon its reserve capacity. A method for estimating this reserve capacity and determining the conservatism of the design is presented. (H.D.R.)

33065 (EUR-4253) CODE CROOC: ORGEL REACTOR CONTAINMENT DESIGN PARAMETERS. Simon, R.; De Wolde, H. I. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center. European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). Jan. 3, 1969. 49p. Dep.

The code CROOC calculates the time functions of temperature, partial and total pressures in two rooms during and after an important leakage of reactor coolant into one of the rooms. The two rooms are supposed to be separated by a rupture disk and both may be provided with water dousing systems for pressure suppression. The present version of the code works without iteration cycles on the base of simplified mass and energy balances and serves essentially for the preliminary design work. The code is fitted with a CALCOMP subroutine, so that all results can be plotted immediately. (auth)

33066 (ORNL-4374) NUCLEAR SAFETY PROGRAM ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1968. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 469p. Dep. CFSTI.

ALUMINUM ALLOYS AND SYSTEMS—corrosion by base borate solutions of, effects of solution and spray on
CARBON (SURFACE-ACTIVE)—sorptive properties for elemental iodine and iodomethane of, effects of humidity on
—sorptive properties for iodomethane of, effects of weathering on
CESIUM ISOTOPES—distribution of aerosol, analysis under LOFT conditions from failed simulated uranium oxide (UO_2) fuel elements of
CHARCOAL—combustion of, effects of fission product decay heat on
COPPER ALLOYS AND SYSTEMS—corrosion by base borate solutions of, effects of solution and spray on
DATA ACQUISITION SYSTEMS—operations of Nuclear Safety Information Center during January to December 1968
FILTERS—performance of high efficiency stainless steel–uranium oxide (UO_2) aerosol
FISSION PRODUCTS—distribution of aerosol, from LOFT condition uranium oxide (UO_2) fuel element failure
—size of aerosol, effects of age, humidity, and time from LOFT condition on
—distribution of aerosol, from Zircaloy 2 clad uranium oxide (UO_2) fuel element failure
—release of, analysis for high temperature gas cooled reactor heated fuel elements of
GRAPHITE—corrosion by steam under high temperature gas cooled reactor accident conditions
IN-PILE LOOPS—design parameters of ORR coolant loss simulating
INFORMATION CENTERS—operations of Nuclear Safety Information Center during January to December 1968
IODINE—distribution of aerosol, analysis under LOFT conditions from failed simulated uranium oxide (UO_2) fuel elements of
—sorption by surface active carbon of, effects of humidity on
—removal by water spray solutions, effects of concentration, exposure, and temperature on
—removal by NSPP spray system of, effectiveness of Run 21 to 54
KRYPTON ISOTOPES—removal from air by methyl phenyl silicone rubber membranes
MEMBRANE FILTERS—effectiveness for krypton and xenon removal from air of methyl-phenyl silicone rubber
METHANE, IODO—distribution of aerosol, analysis under LOFT conditions from failed simulated uranium oxide (UO_2) fuel elements of
—sorption by surface active carbon of, effects of humidity on
—sorption by surface active carbon of, effects of weathering on
—formation of, kinetics for reactor accident environment of
—removal by base borate thiosulfate spray solutions, effects of concentration, temperature, and time on
—removal by NSPP spray system of, effectiveness of Run 21 to 54
NEUTRONS, FAST—effects on mechanical properties of A533 HSST steel plates
NOZZLES—stresses in multiple spherical shell connected, effects of configuration on
NUCLEAR SAFETY PILOT PLANT—removal of elemental iodine and iodomethane in Run 21 to 54 from, effectiveness of spray for
REACTOR CONTAINMENT STRUCTURES—coolant loss accident condition testing of scale model, transient measurements for
—design parameters for antiseismic, review of
REACTOR FUEL ELEMENTS—failure of uranium oxide (UO_2), fission product aerosol distribution under LOFT condition from
—assemblies of Dresden 1 type, effects of emergency spray cooling injection on high temperature
—cladding of uranium oxide (UO_2), effects of coolant loss conditions on Zircaloy
—failure of Zircaloy 2 clad uranium oxide (UO_2), analysis of fission product release from
—release of fission products from heated high temperature gas cooled power
—failure of uranium carbide (UC_2) carbon coated bonded bed particle type, effects of high temperature on
—performance of high temperature gas cooled power reactor uranium carbide (UC_2) particle type, effects of helium and steam on

REACTOR SAFETY—research and development program during January to December 1968, analysis of ORNL
—standards for development of water cooled reactors
REACTORS, GAS-COOLED—fuel elements for high temperature power, fission product release from heated
REACTORS, POWER—fuel elements for high temperature gas-cooled, fission product release from heated
RUTHENIUM ISOTOPES—distribution of aerosol, analysis under LOFT conditions from failed simulated uranium oxide (UO_2) fuel elements of
SCREENS—performance of silver plated honeycomb, for iodomethane distribution
SPRAYS—stability of iodine absorbing, analysis of chemical, radiation, and thermal
STEAM—flow characteristics of jet stream, effects of degassed water temperature on
—corrosive effects on graphite under high temperature gas cooled reactor accident conditions, (E/T)
STEEL—corrosion by base borate solutions of, effects of solution and spray on
—mechanical properties of plate shaped HSST, effects of thickness on
—radiation effects on mechanical properties of A533 HSST, fast neutron
TELLURIUM ISOTOPES—distribution of aerosol, analysis under LOFT conditions from failed simulated uranium oxide (UO_2) fuel elements of
TELLURIUM OXIDES—vapor pressure of, effects of water vapor pressure on
URANIUM OXIDES UO_2—fuel elements of, distribution of fission product released by melting of, analysis of distribution for
XENON ISOTOPES—removal from air by methyl phenyl silicone rubber membranes
ZIRCALOY—mechanical properties of, measurement of high temperature
—fuel element cladding of, effects of coolant loss conditions on (D.C.C.)

33067 (ORNL-TM-2533) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM. Bimonthly Report for January–February 1969. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 154p. Dep. CFSTI.

AEROSOLS—removal rate following coolant accidents of solid, effects of time on
CARBON (SURFACE-ACTIVE)—sorptive properties for elemental iodine and iodomethane of Witco OF-31 and OF-42
CESIUM—removal by NSPP spray system, effectiveness of Runs 58 to 61 for
CHARCOAL—combustion of BC-153, effects of fission product decay heat on
CONCRETES—corrosion by base borate solutions and sprays
DATA ACQUISITION SYSTEMS—operations of Nuclear Safety Information Center during January to February 1969
FISSION PRODUCTS—distribution of aerosol, from LOFT condition fuel element failure
—size of aerosol, effects of age, humidity, and time during LOFT condition on
GRAPHITE—corrosion by steam, effects of concentration on
INFORMATION CENTERS—operations of Nuclear Safety Information Center during January to February 1969
IODINE—sorption by Witco OF-31 and OF-42 surface active carbon of
KRYPTON ISOTOPES—removal from air by methyl phenyl silicone rubber membranes
MEMBRANE FILTERS—effectiveness for krypton and xenon removal from air of methyl phenyl silicone rubber
METHANE, IODO—sorption by Witco OF-31 and OF-42 surface active carbon
—removal by base borate thiosulfate spray solutions, effects of time and temperature on
NUCLEAR SAFETY PILOT PLANT—removal of cesium and uranium particles from, during Runs 58 to 61
REACTOR CONTAINMENT STRUCTURES—coolant loss accident condition testing of scale model, transient measurements for
REACTOR FUEL ELEMENTS—failure of, fission product aerosol distribution under LOFT condition from
—failure of uranium carbide carbon coated bonded bed particle type, effects of high temperature on
REACTOR SAFETY—research and development program during January to February 1969, analysis of ORNL
—standards for development of water cooled reactors
REACTORS, GAS-COOLED—graphite burnoff in high temperature, effects of steam concentration on
REACTORS, POWER—graphite burnoff in gas cooled high temperature, effects of steam concentration on
SHIELDED CONTAINERS—development of fuel transport
SILICONE RUBBERS—membranes of methylphenyl, efficiency for removal of krypton and xenon from air of
STAINLESS STEEL—corrosion by base borate solution and sprays of Type 304 and Type 316
URANIUM—removal by NSPP spray system, effectiveness of Runs 58 to 61 for
URANIUM CARBIDES, UC—fuel elements of carbon coated, effects of high temperature on
XENON ISOTOPES—removal from air by methyl phenyl silicone rubber membranes
ZIRCALOY—mechanical properties of, measurement of high temperature (D.C.C.)

33068 (ORNL-TM-2588) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR MARCH–APRIL 1969. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 143p. Dep. CFSTI.

ALUMINUM ALLOYS AND SYSTEMS—corrosion by base borate solutions and sprays
CESIUM—removal by NSPP spray system of, effectiveness of Run 58 to 62
CHARCOAL—combustion of, effects of fission product decay heat on
DATA ACQUISITION SYSTEMS—operation of Nuclear Safety Information Center, during March to April 1969
FILTERS—performance of high efficiency stainless steel–uranium oxide (UO_2) and uranium oxide (UO_2)–zirconium oxide (ZrO_2) aerosol, effects of humidity on
GRAPHITE—corrosion by steam, (E/T)
INFORMATION CENTERS—operation of Nuclear Safety, during March to April 1969
KRYPTON ISOTOPES—removal from air by methyl phenyl silicon rubber membranes
MEMBRANE FILTERS—effectiveness for krypton and xenon removal from air of methyl phenyl silicone rubber
METHANE, IODO—removal by solutions, effects of additives on
NOZZLES—stresses in multiple and single cylindrical and spherical shell connected, effects of configuration on
NUCLEAR SAFETY PILOT PLANT—removal of cesium and uranium particles in Run 59 to 62
PLATES—mechanical properties of HSST steel, effects of thickness on
REACTOR FUEL ELEMENTS—swelling of Zircaloy clad rod type, effects of coolant loss conditions on
REACTOR SAFETY—research and development program during March to April 1969, analysis of ORNL
—standards for development of water cooled reactors
SHIELDED CONTAINERS—development of fuel element transport
SILICONE RUBBERS—membranes of methyl phenyl, efficiency for removal of krypton and xenon from air of
SPRAYS—effectiveness of NSPP, for removal of cesium and uranium particles during runs 59 to 62
STAINLESS STEEL—stainless steel–UO_2, filters of, effects of humidity on efficiency of aerosol removal by
—corrosion by base borate solutions and sprays of Type 304 and Type 316
STEAM—corrosive effects on graphite, (E/T)
STEEL—plates of HSST, effects of thickness on mechanical properties of
—tensile properties of A 533 HSST, effects of temperature on
URANIUM—removal by NSPP spray system of, effectiveness of Run 59 to 62
URANIUM OXIDES UO_2—stainless steel–UO_2, filters of, effects of humidity on efficiency of aerosol removal by
—UO_2–ZrO_2, removal from air by high efficiency filters of aerosol, effects of humidity on
XENON ISOTOPES—removal from air by methyl phenyl silicone rubber membranes
ZIRCALOY—mechanical properties of, measurement of high temperature
ZIRCONIUM OXIDES—UO_2–ZrO_2, removal from air by high efficiency filters of aerosol, effects of humidity on (D.C.C.)

33069 MEAN ANNUAL SEVERITY: AN EXTENSION OF THE QUANTITATIVE-PROBABILISTIC APPROACH TO REACTOR SAFETY ANALYSIS. Doron, Z. J.; Albers, H. (Nordostschweizerische Kraftwerke AG, Baden, Switzerland). Nucl. Eng. Design, 9: 349-56(Mar. 1969).

The quantitative approach to reactor safety analysis introduced by F. R. Farmer is discussed and extended by continuing the analysis of each branch of an accident to a point where the probable frequency and consequent radioactivity release assigned to it are multiplied together. This product is termed Mean Annual Severity (MAS), and is useful in analyzing the safeguards and accident status of a reactor. In addition to determining the severity of an accident, this approach enables any weaknesses in the overall safety design to be pin-pointed for further analysis and action. As an example, an analysis is made of a loss of coolant accident in a PWR, and the type of conclusions which can be drawn from such an analysis is demonstrated. A comparison is made between the mean annual severity and the maximum credible accident (MCA) approaches and examples demonstrating weaknesses in the MCA approach by means of MAS analysis are presented. 6 references. (auth)

33070 BRUCH-S: A CODE TO INVESTIGATE BLOW-DOWN OF BOILING WATER REACTOR SYSTEMS. Karwat, H. (Institut fuer Mess- und Regelungstechnik, Munich). Nucl. Eng. Design, 9: 363-81(Mar. 1969).

The computer code BRUCH-S is described which has been written to predict possible hydraulic forces during the blow-down of boiling water reactor systems. BRUCH-S is a multinode point model which describes the thermohydraulic transients within the primary coolant system of a boiling water reactor during blow-down. Application of mass, energy and momentum conservation laws to each of nine pressure nodes results in a system of 40 differential equations. The subdivision of the typical boiling water reactor system is shown and the basic thermodynamic and hydrodynamic equations are given. For a typical direct cycle boiling water reactor results of several computer runs are shown and discussed. Typical problems to be studied with BRUCH-S are the rupture of the primary steam line and the rupture of a recirculation line near the inlet to the pressure vessel. The resulting pressure oscillations after the rupture of a recirculation line are to a great deal influenced by the assumed mode of fracture of the recirculation pipe and the geometric design of the primary system. 4 references. (auth)

33071 NUCLEAR SAFETY. Volume 10, Number 4. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Laboratory, July–Aug. 1969. 78p. GPO $0.60.

Information on various aspects of nuclear safety is presented; included is information on: the OECD Committee on Reactor Safety Technology, effects of the expanding nuclear industry on aquatic communities, missile generation and protection for light water cooled reactors, containment system testing, summary of IAEA symposium on radioactive wastes, summary of air cleaning conference, transportation regulations for radioactive materials, operating experience incidents, nuclear safety research and development projects, summaries of regulatory review of power reactor projects, and proposed changes in 10 CFR as of April 1, 1969. Separate abstracts are prepared for each of the 9 articles. (M.L.S.)

For abstracts of individual sections see: 31511, 31683, 33012, 33072, 33073–33076, and 33091.

33072 COMMITTEE ON REACTOR SAFETY TECHNOLOGY. Smets, Henri B. (OECD, Paris). Nucl. Safety, 10: 287-92 (July-Aug. 1969).

CREST is an international committee of reactor safety experts set up in 1965 by the European Nuclear Energy Agency, a branch of OECD. Its aim is to improve international cooperation on the fundamental aspects of research related to nuclear reactor safety. The main topics studied by CREST so far have been heat transfer in short-term transients, loss of coolant, effects of shocks in nuclear reactors, initiation and propagation of cracks in steel pressure vessels, fission-product research, behavior of graphite, reliability of components, and safety evaluation of reactors. (auth)

33073 MISSILE GENERATION AND PROTECTION IN LIGHT-WATER-COOLED REACTORS. Gwaltney, Richard C. Nucl. Safety, 10: 300-7(July-Aug. 1969).

All reactor designs include some consideration that equipment components such as valve bonnets, valve stems, and instrument thimbles might become missiles under certain accident conditions. Most designs include protection from missiles arising from rotating machinery, and a few include consideration of external missiles such as wind-carried objects and aircraft. Little consideration is given to missiles or shock waves arising from massive failure of a pressure vessel since this is considered by manufacturers to be an incredible event. Analytical methods used to calculate the velocities of presently postulated missiles are considered conservative. Penetration and perforation formulas presently in use were derived from military data and may be entirely applicable to light-water-cooled reactor safety analyses. 35 references. (auth)

33074 TESTING OF CONTAINMENT SYSTEMS USED WITH LIGHT-WATER-COOLED POWER REACTORS. Zapp, Frank C. Nucl. Safety, 10: 308-15(July-Aug. 1969).

An evaluation of the testing of containment systems used with light-water-cooled nuclear power reactors was made through discussions with members of the nuclear power industry and studies of published literature, reports of leakage-rate tests, technical specifications, and information available in preliminary and final safety-analysis reports and their supplements. The studies indicated that integrated leakage-rate test results are not currently being reported in a manner that is conducive to comparisons between plants or to an independent evaluation of the errors involved. In most cases there is insufficient information presented in the leakage-rate test reports to adequately support the degree of accuracy claimed or to give confidence in the leakage result reported. A major need appears to be that of providing guidelines for correctly defining the leakage-rate tests so that the accuracy and significance of the results can be predicted before the test is run. The technology of containment-systems testing is relatively well developed, but additional research and analysis are warranted to improve leakage-rate testing accuracy and reliability; correlate leakage under test conditions with that expected under accident conditions; improve and develop continuously monitoring integrated-leakage and/or leakage-rate surveillance systems; investigate methods of continuously monitoring all containment engineered safety features; and provide realistic and meaningful procedures for testing the capability and reliability of reactor containment engineered safety features under accident conditions. (auth)

33075 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. Nucl. Safety, 10: 348-54(July-Aug. 1969).

Progress on nuclear safety research and development projects is summarized for: Fast Reactors–meltdown studies, coolant dynamics, material behavior and energy transfer, posttransient examination of unfailed molten and powder fuel specimens, sodium boiling studies, characterization of energy and aerosols generated from sodium pool fires, radioactivity and contamination control, and fission product release studies; Gas Cooled Reactors–steam-graphite reaction studies; Effluent Control–Columbia River sediment studies, model river systems studies, reactor fuel transport safety, dispersion of radioactive aerosols and gases in the atmosphere, and development of analytical model to predict travel of radioactive gases discharged to the ground; General–reactor operators study and Nuclear Safety Information Center operations. 27 references. (M.L.S.)

33076 SAFETY-RELATED OCCURRENCES REPORTED IN FEBRUARY–MARCH 1969. Cramer, E. N. (comp.). Nucl. Safety, 10: 343-7(July-Aug. 1969).

A compilation of safety-related occurrences is reported for various research, test, and power reactors in the U. S.; these include: heat exchanger tube failures in HFIR; a common failure mode for the magnet and scram circuit for the Cornell TRIGA reactor; phase interruption in control rod drive circuit caused faulty drive signal in N.S. Savannah; failures in swaged tube fittings, feedwater control problems, and ion chamber sensitivity to control rod position at LACBWR; unscheduled trips at Connecticut Yankee caused by inverters and turbine oil pressure malfunctions; effects of polyethylene covers on ion chambers in the VPI Research Reactor and in Shippingport; an overestimation of core flow and loss of on-site and off-site power at Humboldt Bay. 18 references. (M.L.S.)

Power Conversion Systems

33077 (WARD-2000-22) STEAM GENERATOR CONCEPT SELECTION. 1000 MWe LMFBR Follow-on Study. Keyfitz, I. M. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jan. 1968. Contract 31-109-38-2000. 48p. Dep. CFSTI.

For Argonne National Lab., Ill.

Seven different Na-heated steam generator concepts are described and compared on the basis of safety, reliability, complexity, ease of maintenance, and economy. It is concluded that the Westinghouse concept should prove successful and economic provided sufficient design and development are performed. 27 references. (H.D.R.)

33078 (WARD-2000-23) SURVEY OF STATE-OF-THE-ART OF INTERMEDIATE HEAT EXCHANGERS. 1000 MWe LMFBR Follow-on Study. Sturiale, L. A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Mar. 1968. Contract 31-109-38-2000. 49p. Dep. CFSTI.

For Argonne National Lab., Ill.

Information available on intermediate heat exchangers (IHX) used in Na-cooled reactor systems is summarized. The survey is combined with a qualitative evaluation of significant design features to provide a basis for selection of the IHX configuration in the 1000 MW(e) LMFBR reference design concept. 18 references. (H.D.R.)

Research and Test Reactors

Refer also to abstracts 31495, 31540, 31579, 32040, 32949, 33037, 33044, 33066, 33076, and 33118.

33079 (BNWL-941) FAST FLUX TEST FACILITY. Periodic Technical Report, October 1968–February 1969. Astley, E. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 253p. Dep. CFSTI.

CHROMIUM ISOTOPES CR-51—deposition in FTR cooling system, effects of fuel element failure on
COBALT ISOTOPES Co-60—deposition in FTR cooling system, effects of fuel element failure on
CRITICAL ASSEMBLIES—fuel element assemblies of NPIF, effects of sodium heating on pressure in
CRITICALITY STUDIES—calculation of water moderated and reflected plutonium oxide (PuO_2)–uranium oxide (UO_2) systems
FAST FLUX TEST FACILITY—design and development during October 1968 to February 1969
—accidents in, energy release from maximum
—fuel elements for, fabrication of pellet type
FAST TEST REACTOR—design and development during October 1968 to February 1969
—core concepts for, design evaluation of
—physics measurements for, computer program calculation of
—stress analysis for
—loop test mockup for, conceptual design of one half scale hydraulic
—cooling system for, radioisotope transport and deposition in
—instrumentation for, description of in core
—fuel assemblies for, fabrication of pin type
MANGANESE ISOTOPES Mn-54—deposition in FTR cooling system, effects of fuel element failure on
NEUTRONS, FAST—effects on tensile properties of Type 316 stainless steel
—effects on dimensional changes in Type 304 and 316 stainless steel
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, fuel elements of, burnup of pin type
REACTOR FUEL ELEMENTS—assemblies of NPTF, effects of sodium heating on pressure in
—fabrication of FTR pin type assemblies of
—fabrication of FFTF pellet type
—burnup in plutonium oxide (PuO_2)–uranium oxide (UO_2) pin type
REACTOR SAFETY—accidents in FFTF, energy releases from maximum
SODIUM—decontamination of FFTF, requirements for
STAINLESS STEEL—radiation effects on tensile properties of Type 316, measurement of fast neutron
—radiation effects on dimensional changes in Type 304 and 316, measurement of fast neutron
TUBES—tensile properties of hexagonal shaped Type 316 stainless steel, effects of time and temperature on
URANIUM OXIDES UO_2—PuO_2–UO_2, fuel elements of, burnup of pin type (D.C.C.)

33080 (BNWL-1053) REACTOR PHYSICS QUARTERLY REPORT, JANUARY–MARCH 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 85p. Dep. CFSTI.

CRITICAL ASSEMBLIES—physics measurements for NPTF vertical core concept
CRITICALITY STUDIES—measurement of PRTR heavy water cooled and moderated 31 and 55 element cores, (E/T)
—measurement of homogeneous plutonium oxide (PuO_2)–uranium oxide (UO_2) water lattice
—measurement of sandwich arranged plutonium oxide (PuO_2)–polystyrene and uranium oxide (UO_2) slabs
—measurement of plutonium nitrate ($Pu(NO_3)_4$) solutions in slab geometry, (E)
PHYSICAL CONSTANTS TESTING REACTOR—physics measurements of, multigroup method for, (T)
PLUTONIUM NITRATES $Pu(NO_3)_4$—critical mass of solutions of, in slab geometry, (E)
PLUTONIUM RECYCLE CRITICAL FACILITY—neutron flux peaking and dipping in 13 element core of, gold foil activation analysis of
—neutron noise in heavy water moderated plutonium oxide (PuO_2)–uranium oxide (UO_2) 19 rod cluster, (E/T)
PLUTONIUM RECYCLE TEST REACTOR—fuel burnup calculations for Batch Core in
—criticality of heavy water cooled and moderated 31 and 55 element cores in, (E/T)
RADIATION DETECTORS, FISSION FOIL—neutron flux peaking and dipping in PRCF 13 element core by gold foil
—neutron flux measurements by indium foil, comparison with boron fluoride (BF_3) proportional counter
RADIATION DETECTORS, PROPORTIONAL—neutron flux measurements by boron fluoride (BF_3), comparison with indium foil
REACTORS—physics studies on, digital computer programs for
REACTORS, FAST—physics studies on, summary of January to March 1969
—kinetics of, comparison of MELT 2 with FORE 2 and NUTIGER computer programs for
REACTORS, THERMAL—physics studies on, summary of January to March 1969 (D.C.C.)

33081 (GA-9329) LATTICE PHYSICS STUDIES. Quarterly Progress Report for the Period Ending March 31, 1969. Trimble, G. D.; Neill, J. M.; d'Oultremont, P. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 14, 1969. Contract AT(04-3)-167. 33p. (EURAEC-2106). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Thermal neutron spectrum measurements were performed at room temperature, 120°C, and 260°C in the 1.3 inch pitch lattice of Al–Pu fuel elements with a volume ratio of water of 5.94. The measurements were repeated in a 1.0 inch pitch lattice. The fabrication of the experimental tank for studying thermal neutron spectra in plutonium nitrate solutions is described. The glove box installation for the plutonium nitrate experiment is illustrated. The calibration of 36 BF_3 detectors is described. Thermal neutron flux distributions are presented for foil activation measurements in plutonium nitrate solutions. (9 references) (D.C.C.)

33082 (GEAP-5754) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Nineteenth Quarterly Report, November 1968–January 1969. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Feb. 1969. Contract AT(04-3)-540. 67p. Dep. CFSTI.

Development of a suitable detector system for recording the transient flux during SEFOR experimental programs is described. Circuit diagrams of the core flux detector system are included. The FRED reactivity excursion device is described. A description of fuel rod fabrication and associated core components for SEFOR is presented. The SEFOR startup testing and transient testing programs are reviewed. The performance of Type 304 stainless steel mesh full-flow strainers for liquid Na are analyzed. Operations and construction tasks completed during November 1968 to January 1969 are listed. (D.C.C.)

33083 (IN-1228) REACTOR ENGINEERING BRANCH ANNUAL REPORT, FISICAL YEAR 1968. Covington, E. D. (ed.) (Idaho Nuclear Corp., Idaho Falls). Feb. 1969. Contract AT(10-1)-1230. 148p. Dep. CFSTI.

Topics discussed include: materials research; reactor fuels and materials development; engineering experiments; reactor training; and critical facilities. Separate abstracts are included for each of the five sections presented. (D.C.C.)

For abstracts of individual sections see: 33084, 33085, and 33117–33119.

33084 (IN-1228, pp 74-110) ENGINEERING EXPERIMENTS. (Idaho Nuclear Corp., Idaho Falls).

Experimental and analytical fuel element investigations have been directed toward better defining the ATR operating conditions and limits. Local coolant flow rates were measured in the ATR core and factored into the computer code used in fuel element thermal hydraulic analysis. 14 references. (auth)

33085 (IN-1228, pp 114-48) CRITICAL FACILITIES. (Idaho Nuclear Corp., Idaho Falls).

The first critical fuel loading in the ATR was attained July 2, 1967. The subsequent zero-power experiment program, which had also been performed previously in the ATRC, confirmed the nuclear correspondence between the two reactors. Additional low power experiments in the ATR have strengthened reactor physics correlations with the ATRC and provided data on temperature-induced reactivity effects which could not be readily obtained from the ATRC. Increasing reactor coolant temperature had only a small effect on shim and safety rod worths; however, the outer shim worths increased significantly when the experiment loop temperatures were raised. Measurements in typical ATR experiment irradiation positions show that fast (i.e., E > 1 MeV) neutron flux and gamma heating can be predicted from low power measurements in the ATRC within 5 and 20%, respectively. The power spectral density, from zero-power noise measurements, shows prominent resonances attributed to flow-induced vibrations of the in-pile experiment tubes. Power distribution measurements in the ATRC show that the core hot-spot power generation can be reduced 18% by using radially zone-loaded fuel elements, without affecting the fission rate in adjacent loop experiments. The effect on other experiments in the core of changing or removing a loop experiment train can be minimized to the point of insignificance if the reactivity effect of the change or removal is compensated by the adjacent outer shims. A computer program, GRIPE II, was written for the analysis of data from pulsed-neutron experiments in either critical or subcritical reactors. Detailed fission rate measurements in the same fuel loading in both ETR and ETRC have provided a comprehensive comparison of the two reactors. Some relatively large (e.g., 20%) differences were noted in the power distribution, which have been tentatively attributed to inadequate experiment mock-ups in the ETRC. 10 references. (auth)

33086 (KFK-719) THERMAL HIGH FLUX REACTORS: A BIBLIOGRAPHY WITH DATA. Homma, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Dec. 1968. 72p. (In German). Dep. CFSTI.

Characteristic data, drawings, and literature references are presented on the following steady state high flux reactors with a maximum thermal neutron flux of about 10^{15} n $cm^{-2}s^{-1}$ and above: Argonne Advanced Research Reactor (Argonne), Advanced Test Reactor (NRTS, Idaho), Belgian Reactor 2 (Mol), Franco-German High Flux Reactor (Grenoble), High Flux Beam Research Reactor (Brookhaven), High Flux Isotope Reactor (Oak Ridge), Mighty Mouse Reactor (ANL-study), Savannah River High Flux Demonstration (Savannah River Plant), Soviet Reactor MIR (Melekess), Soviet Reactor SM-2 (Melekess), and U. K. High Flux Reactor Study (Harwell). (auth)

33087 (UCB-34-P-161-1) NEUTRON SPECTRUM MEASUREMENTS. Progress Report. Amster, Harvey (California Univ., Berkeley). Dec. 20, 1968. Contract AT(11-1)-34. 9p. Dep. CFSTI.

Development of a set of leakage spectrometers with calculated properties is reported. The spectrometers consist of small spherical epithermal resonance absorbers at the core of a B covered polyethylene sphere. Because of the effects of leakage and moderation in the polyethylene, the cores will have different activation energy dependencies peaking in the kilovolt range. The experimental configuration at the University of California TRIGA reactor is described. (H.D.R.)

33088 (UCB-34-P-161-2) NEUTRON SPECTRUM MEASUREMENTS. Progress Report. [Amster, Harvey] (California Univ., Berkeley. Dept. of Nuclear Engineering). Apr. 1, 1969. Contract AT(11-1)-34. 4p. Dep. CFSTI.

Progress in the selection of materials and geometry for the development and testing of leakage spectrometers is presented. Calculations are included for the substitution of Au for a Mn resonance absorber. Preparations for the calibration experiment are described. (H.D.R.)

33089 IRT TYPE NUCLEAR RESEARCH REACTOR. Vorob'ev, A. A.; Chuchalin, I. P. (Tomsk Polytechnic Inst., USSR). Vestn. Vyssh. Shk., No. 4, 50-3(1968). (In Russian).

A detailed description is given of the characteristics and operation of the new nuclear reactor put into operation at the Scientific Research Institute of Nuclear Physics, Electronics, and Automation at the Tomsk Polytechnic Institute, in July 1967. The reactor, a heterogeneous IRT type, is distinguished by simplicity of design, operational safety, reliability, and relatively low cost. Its parameters include distilled water, which acts as a moderator, heat carrier, and shield; 8 horizontal channels, each 100 mm in diameter; a horizontal 150-mm diameter through channel leading to the radiation facility; a 230 mm diameter channel with dismantleable box for irradiating samples 600 × 700 × 500 mm; and 18 vertical experimental channels 23 to 190 mm in diameter. The reactor, a research tool, is used to obtain radioactive isotopes for science and industry. (JPRS)

33090 HIGH FLUX REACTOR FOR THE MAX VON LAUE-PAUL LANGEVIN INSTITUTE AT GRENOBLE. Chatoux, Jean (Commissariat a l'Energie Atomique, Saclay, France); Eisermann, Werner. Energ. Nucl. (Paris), 11: 84-92(Mar.-Apr. 1969). (In French).

A high flux reactor is being built in Grenoble for the Franco-German Max von Laue-Paul Langevin Institute. A flux of thermal neutrons of 15^{15} $n/cm^2/sec$, produced by means of a heavy water-cooled and moderated core, will be used for experiments in the fields of nuclear physics and solid physics. Design parameters are described. (auth)

33091 STARTUP AND OPERATING EXPERIENCE AT THE UNIVERSITY OF MISSOURI (COLUMBIA) RESEARCH REACTOR. Cox, Edwin L. (Univ. of Missouri, Columbia). Nucl. Safety, 10: 337-43(July-Aug. 1969).

The University of Missouri research reactor (MURR) has had problems with building leakage, control-rod calibration, spurious control-rod drop, and neutron instrumentation. Although considerable difficulty was experienced with the resistance of linear ball bushings in control-blade mechanisms, there was no doubt about the reactor being safe. The small core and wide control blades between core and reflector made control-blade calibration by rod-drop methods so dependent on detector position that the technique was invalidated. Additional fine control of compensating voltage has been added to make the compensated ion chambers properly compensated following operation, but the chambers are still sensitive to shifts in neutron-flux patterns induced by control-blade motion. (auth)

33092 IRRADIATION FACILITIES NO. 2: BARN. Wageningen, Netherlands, Association EURATOM-ITAL, 1969. 16p.

The design parameters of the BARN reactor and its experimental facilities are described. Examples of irradiation data are presented. (D.C.C.)

Rocket and Space Reactors

Refer to abstracts 31447 and 32031.

Process Heat and Desalination Reactors

33093 (STI/PUB-210) VALUE TO AGRICULTURE OF HIGH-QUALITY WATER FROM NUCLEAR DESALINATION. Panel Proceedings Series. Report of a Panel Held in Vienna, 30 October-3 November 1967. (International Atomic Energy Agency, Vienna (Austria)). Mar. 1969. 286p. (In French and English). (CONF-671082). IAEA: $7.00; Austrian Schillings 181,-; £2.18.4; F.Fr. 34,30; DM 28,-.

The contents include papers in which some economic and agricultural aspects are discussed, such as the value to agriculture of high-quality water from nuclear desalination, cost of irrigation water, water quality and yield depression, tolerance of certain crops to salinity and agronomic aspects of irrigation with brackish water. A conversion table is given in an annex. Each paper is in its original language (19 English and 3 French) and is preceded by an abstract in English with one in the original language if this is not English. Discussions are in English. 102 references. (auth)

Marine and Portable Power Reactors

33094 (ORNL-TM-2330) STATIC AND DYNAMIC MEASUREMENTS WITH THE ARMY PULSE RADIATION FACILITY REACTOR. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 109p. Dep. CFSTI.

Studies have been made of the nuclear characteristics of an unreflected, unmoderated cylindrical assembly of 90 wt % U (93.2 wt % ^{235}U), 10 wt % Mo alloy at low power and of the time-dependent behavior of the power in the assembly following a rapid establishment of superprompt criticality with negligible initial neutron population. The low power experiments included measurements of a variety of critical configurations, the reac-

tivity associated with the reactor parts and with materia' which could be placed near the reactor, fission density distrib ions, and prompt neutron decay constants by both the Rossi-α and pulsed neutron techniques at delayed criticality and at various subcritical conditions. The measured reactivities and decay constants are compared with the results of S_8 neutron transport theory calculations. In the studies of the dynamic behavior, rapid additions of reactivity up to 14 cents above prompt criticality resulted in pulses yielding as many as 3.68×10^{17} fissions with prompt reactor periods as short as 12.4 μsec and with temperature increases as large as 880°C. In these experiments the reactor produced pulses of 2×10^{17} fissions without any damage. A pulse of 2.35×10^{17} fissions resulted in permanent elongation of the bolts holding the core together and a pulse of 2.63×10^{17} fissions cracked some of the core parts. The dynamic experiments verified that pulses could be produced satisfactorily even when the reactivity during the interval immediately preceding the pulse, when the neutron population decayed, was only about 1.7 dollars below delayed criticality. The dynamic experiments also indicated improvements to be incorporated in future designs. 15 references. (auth)

Production Reactors

33095 (DUN-SA-87) AUTOMATIC RANGING PICOAMMETER FOR INDICATING REACTOR POWER LEVEL DEVIATION. Tonder, J. A.; Bollinger, R. K. (Douglas United Nuclear, Inc., Richland, Wash.). Jan. 12, 1969. 3p. (CONF-690609-5). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

A wide-range instrumentation system which provides full scale deviation instrument deflection for only 0.25% of total power and can follow an abrupt excursion of a scram from full power is described. The picoammeter is installed at the Hanford N-Reactor. (H.D.R.)

Reactor Theory

Refer also to abstract 33080.

33096 (RT/FI-(69)16) NEUTRON FLUX DISTRIBUTION IN A PLANE HETEROGENEOUS CRITICAL ASSEMBLY. Trombetti, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 20p. Dep.

An exact solution to the neutron transport equation for a plane, heterogeneous, finite or infinite critical assembly is presented. The criticality condition corresponds to the vanishing of an infinite determinant, whose elements are given an explicit, closed form expression, which can be used directly in numerical applications. The spatial distribution of the total flux is expressed in terms of exponential functions of higher order and Gegenbauer's ultraspherical polynomials. (9 references) (auth)

33097 (TID-24512) REACTOR-NOISE ANALYSIS IN THE TIME DOMAIN. AEC Critical Review Series. Pacilio, Nicola (Argonne National Lab., Ill. Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Apr. 1969. 102p. Dep. CFSTI.

Reactor noise analysis techniques, results and analyses are reviewed in detail. Working equations and descriptions are given for the following types of noise analysis: the Rossi-α method; endogenous pulsed source method, autocorrelation and cross-correlation functions of the neutron counting rate, Feynman variance method, expected number of correlated pairs method, Bennett variance method, third-order analysis and the expected number of correlated-neutron-triplets method, covariance method, zero-count probability method, Polya-model method, other related probability methods, time interval from a random origin method, pulse to pulse time interval method, intermediate methods (even- or odd count, etc.), polarity autocorrelation and cross-correlation method, and covariance method via polarity detection. 143 references. (M.L.S.)

33098 (WAPD-TM-855) PROBABILITY DISTRIBUTIONS OF NEUTRONS AND PRECURSORS IN A STATIONARY REACTOR WITHOUT TEMPERATURE FEEDBACK. Burger, J. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1969. Contract AT(11-1)-Gen-14. 13p. Dep. CFSTI.

The extent of theoretical knowledge of neutron distributions is reviewed. The mathematical distribution for a system of both neutrons and delayed neutron precursors remains unknown. Neglecting delayed neutrons, the assumptions leading to the negative binomial distribution are listed. The negative binomial distribution should specialize to the critical distribution, whose known probability generating function has not yielded rigorous probabilities. The connection between the continuous gamma probabilities and the rigorous gamma probabilities is noted. 9 references. (auth)

33099 KINETICS OF THE GAS REACTOR. Namiki, Mikio; Morishima, Nobuhiro (Waseda Univ., Tokyo). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 43, 53-64(Feb. 1969). (In Japanese).

The fundamental theory of a gas reactor is developed by the use of mathematical method of nonlinear oscillations, and is applied to the following typical cases: periodic supply and stepwise supply of fuel. Both the modified perturbation method and the numerical analysis are used to investigate the dynamic properties. It is shown that the gas reactor is quite stable because of the large negative temperature coefficient. (auth) (NSA of Japan)

33100 ESCAPE PROBABILITIES IN CLOSE-PACKED LATTICES. Carlsmith, R. S.; Steiner, D. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 37: 166-7(July 1969).

Calculation of escape probabilities for repetitive close-packed lattices is discussed; calculations are tabulated for escape probabilities with Dancoff corrections greater than 0.346 and with relatively transparent rods. 11 references. (M.L.S.)

33101 REACTOR CONTROL USING A NEW MULTIVARIABLE DESIGN TECHNIQUE. Slivinsky, Charles R. (Univ. of Missouri, Columbia); Weaver, Lynn E. Nucl. Sci. Eng., 37: 163-6(July 1969).

Procedures for calculating the compensation matrices for reactor control systems are outlined. Canonical and standard forms of the matrices are developed. The control equations for a coupled-core reactor are solved to illustrate the mathematical technique. (M.L.S.)

33102 THEORY OF PULSED NEUTRON EXPERIMENTS IN POLYCRYSTALLINE MEDIA. Conn, Robert; Corngold, Noel (California Inst. of Tech., Pasadena). Nucl. Sci. Eng., 37: 85-93(July 1969).

A theory of pulsed neutron experiments for thermal, nonmultiplying polycrystalline media is presented. Existence theorems for discrete eigenvalues are examined together with the role of various continua. It is found that discrete eigenvalues can exist with values greater than the minimum collision frequency. A new continuum contribution, directly related to elastic scattering, provides a bound for the discrete eigenvalues in small assemblies. 29 references. (auth)

33103 DISCRETE STOCHASTIC MODEL FOR NEUTRON MODERATION. Williamson, T. J. (Naval Postgraduate School, Monterey, Calif.); Albrecht, R. W. Nucl. Sci. Eng., 37: 41-58 (July 1969).

A general model is developed for numerical calculations of neutron slowing down parameters and functions in homogeneous media of any composition. The model is based on a representation of slowing down as a discrete time, discrete state Markov process. It is shown that the weighting function normally used in calculating elements of a multigroup stepping array is not optimal for discrete calculations. An improved weighting function is developed and used to define a model for Markovian transition probabilities. The relation defining Markov n-step transition matrices is utilized to generate stepping matrices that are consistent, accurate, and stable regardless of energy range or time step width. This relation is also used to develop a calculational technique in which a stepping matrix follows the neutron pulse downward in energy, greatly extending the energy range and number of states or groups that may be used in a single calculation. The model is evaluated by comparing the solutions it produces to certain exact solutions of the slowing down equation. It is, in turn, used to evaluate some asymptotic and approximate analytical solutions of the slowing down equation and to explore some problems in slowing down theory. 28 references. (auth)

33104 METASTATIC METHOD IN NUCLEAR REACTOR CORE KINETICS CALCULATIONS. Galati, A. (CNEN, Rome). Nucl. Sci. Eng., 37: 30-40(July 1969).

A quasi-static method is proposed for evaluating spatial effects on nuclear reactor kinetics. The neutron flux shape is calculated approximately as an asymptotic solution of the two-group space-time diffusion equations, where delayed neutron behavior is included. Two iterative procedures are alternatively used according to the amount of reactivity involved. The first one operates until prompt criticality is reached. The second procedure replaces the first one as soon as the reactor goes superpromptcritical. The main feature of the approach adopted is the possibility of selecting an initial guess such that convergence is reached at

the first iteration. The matter is then reduced to solving two eigenvalue problems. Theoretical and numerical comparisons with Henry's adiabatic model outline the main role of perturbed adjoint fluxes and correct neutron-flux shape (the second agent only for superprompt critical excursions) in defining the generation time and reactivity. When compared with the exact solution, results of sample problems show substantial accuracy in the flux shape and amplitude. In subprompt critical excursions, only the synthesis method is as accurate as the metastatic one and yields errors of few percent at the flux peak. In the reactivity range above prompt critical, differences between the exact results and the metastatic ones are unessential. 9 references. (auth)

33105 STABILITY CRITERION FOR SPACE-DEPENDENT NUCLEAR-REACTOR SYSTEMS WITH VARIABLE TEMPERATURE FEEDBACK. Kastenberg, William E. (Univ. of California, Los Angeles). Nucl. Sci. Eng., 37: 19-29(July 1969).

A general formalism for the determination of stability criteria by the method of comparison functions is derived for nuclear reactors whose system dynamics are governed by a coupled set of space-dependent nonlinear differential equations. The results obtained are applicable to the nonlinear multigroup diffusion equations with temperature feedback. A stability criterion for the nontrivial equilibrium state is presented in a theorem. In addition, two corollaries are presented for the particular cases of negative feedback. The criteria so obtained represent a measure of the "dissipative" forces as estimated by the eigenvalues of the linearized problem versus a measure of the "disruptive" forces caused by the feedback. If the net effect is dissipative then the system is asymptotically stable in the sense of Lyapunov. Two examples are presented to illustrate the formalism and use of the criteria. In the second example, a stability criteria for two-group theory with linear temperature feedback is derived directly from the equations of motion by this method. 18 references. (auth)

33106 SOLUTION OF THE ONE-VELOCITY TRANSPORT EQUATION IN TERMS OF SYNTHETIC KERNELS. Henryson II, Herbert (Argonne National Lab., Ill.); Selengut, David S. Nucl. Sci. Eng., 37: 1-18(July 1969).

An approximate formalism is derived for solving problems in the one-velocity transport of neutrons in convex, isotropically scattering media. The integral transport equation is transformed to an equivalent infinite medium problem to which the synthetic kernel method may be applied. It is then shown that the neutron flux may be approximated by the solution of a set of coupled-diffusion type differential equations. These equations and their related boundary conditions are of the same form as the few-group diffusion equations so that solution may be obtained by use of existing multidimensional computer codes. Finally, the new formalism is applied to a number of simplified, though realistic, problems and the results are compared with corresponding results provided either by rigorous treatment or by other approximate theories. In general, the accuracy of the formalism and the computational effort required are comparable with the simplified spherical harmonics method. In addition, the flexibility available in choosing the parameters of the synthetic kernel offers the possibility of tailoring kernels to specific design problems. 28 references. (auth)

Experimental Applications

Refer also to abstracts 33041, 33042, 33045, and 33070.

33107 (BNWL-1057) USERS AID: PROGRAMS LEARN AND LIKELY. Seybold, G. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 122p. Dep. CFSTI.

Information is presented to aid users of least squares fitting codes, LEARN and LIKELY. The theory and fitting techniques are based upon second order Taylor expansions of the mean square misfit and utilize standard minimization formulae to obtain convergence. A brief explanation is given of the program logic along with the subroutines pertinent to running the codes. Instructions on the necessary input to the codes are given. The input and output of several sample cases are included. 8 references. (auth)

33108 (CEA-R-3640) STUDY OF HETEROGENEOUS MULTIPLYING AND NON-MULTIPLYING MEDIA BY THE NEUTRON PULSED SOURCE TECHNIQUE. Deniz, Valentine (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 194p. (In French). Dep. Thesis. Submitted to Univ. of Paris, Orsay, France.

The pulsed neutron technique consists essentially in sending in the medium to be studied a short neutron pulse and in determining the asymptotic decay constant of the generated population. The variation of the decay constant as a function of the size of the medium allows the medium characteristics to be defined. This technique has been largely developed recently and has been applied as well to moderator as to multiplying media — in most cases homogeneous ones. This technique was applied to lattices to see if useful information could be collected for lattice calculations. A general theoretical study of the problem and results and interpretation of a series of experiments made on graphite lattices are presented. There is good agreement for non-multiplying media. In the case of multiplying media, it is shown that the age value used previously in graphite lattice calculations is over-estimated by about 10%. (auth)

33109 (CEA-R-3696) REACTIVITY MEASUREMENTS ON A SUBCRITICAL NUCLEAR REACTOR USING STATISTICAL FLUCTUATIONS OF THE NEUTRON FLUX. Feghahati, Emad-ed-Din (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1969. 87p. (In French). Dep. Thesis. Submitted to Univ. of Paris, Orsay, France.

The possibility of constructing an apparatus for measuring the reactivity of a sub-critical nuclear reactor by using a spectral analysis of the variations in the output signal of a counter is discussed. The method proposed consists in the measurement of the spectral density in two frequency bands, and in the determination of the "uncorrelated" components so as to obtain the "correlated" components, the ratio of these two correlated components giving the reactivity if β/l is known. It is concluded that this method could be applied with the help of a simple apparatus having a measurement range of up to $-5{,}000$ pcm. Since the efficiency of the detector cannot be increased above a certain value, the accuracy depends largely on the time of measurement: it is shown that it is possible to measure $-3{,}000$ pcm with an accuracy of ±5 percent for a time of measurement of 600 seconds. (auth)

33110 (KAPL-P-3812) NUMERICAL EVALUATION OF SPATIALLY-DEPENDENT DYNAMIC REACTOR SYSTEMS USING PSEUDORANDOM SIGNALS. Rydin, R. A.; Hooper, R. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1969. Contract W-31-109-Eng-52. 44p. (CONF-690609-15). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

The cross correlation method of determining the impulse response of a dynamic system, which has been widely used in experiments, is applied numerically to a complicated mathematical model of a spatially dependent reactor system, and is concluded to be a practical alternative to analog computer analysis. The method is applied using two families of periodic discrete level signals as the input perturbation. It is demonstrated that a relatively new class of signals, having three possible levels, which has had very limited use to date, leads to a more accurate determination of the impulse response in the presence of strong system nonlinearities than do the better known and more widely used binary signals. 14 references. (auth)

33111 ANALYSIS OF PULSED NEUTRON EXPERIMENTS IN POLYCRYSTALLINE MEDIA USING A MODEL KERNEL. Conn, Robert; Corngold, Noel (California Inst. of Tech., Pasadena). Nucl. Sci. Eng., 37: 94-103(July 1969).

A detailed investigation of pulsed neutron experiments in thermal, nonmultiplying, polycrystalline moderators is presented. A transport approximation of the spatial dependence of the neutron density and a simplified scattering kernel are employed. The dispersion law is examined in some detail both analytically and numerically and comparisons are made with experimental data and multigroup calculations for Be and graphite. It is found that even in very small systems, the decay may be well represented by a single exponential. However, if the system is too small, the very long time behavior is controlled by a continuum, non-exponential, contribution. 26 references. (auth)

33112 FAST NEUTRON SPECTRUM FOR A SUBCRITICAL SECTION OF A HOMOGENEOUS ^{235}U-POLYETHYLENE CRITICAL ASSEMBLY. Cohen, S. C.; Moore, R. A.; Young, J. C.; Russell, J. L. Jr. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 37: 111-26(July 1969).

The neutron spectrum for a subcritical section of the thermionic critical experiment, Assembly No. 1, was measured by the pulsed source, time-of-flight method. The measurement was performed in a calculable slab configuration so that the results would be directly applicable to the critical assembly. The measured spectrum was compared with multigroup transport calculations based upon various cross-section data sets and cross-section treatments. The results demonstrate the need for consideration of unresolved resonance self-shielding in ^{235}U, and suggest that the ^{235}U absorption cross-section data may be slightly high at energies between 100 eV and 2 keV. 24 references. (auth)

33113 TIME-DEPENDENT ANALYSIS OF SUBCRITICAL AND NONMULTIPLYING SYSTEMS. d'Oultremont, P. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 37: 104-10(July 1969).

A method of solving the time-energy dependent problem in reactor physics is explained. This method uses an iterative process to solve the steady-state Boltzmann equation and takes advantage of the implicit time variable concealed in this equation and released by the iterative calculations. Various examples of calculations are presented for fast and thermal reactors. They reveal some interesting features of kinetics neutron population and provide information for understanding reactor kinetics and time-of-flight spectra obtained both in fast and thermal subcritical systems. 13 references. (auth)

33114 TEMPERATURE DEPENDENCE OF EPITHERMAL NEUTRON CAPTURE AND FISSION IN $^{235}UO_2$. Schoenig, F. C. Jr. (Rensselaer Polytechnic Inst., Troy, N. Y.); White, F. A.; Feiner, F. Nucl. Sci. Eng., 37: 66-84(July 1969).

Measurement of the temperature dependence of epithermal neutron capture and fission in enriched UO_2 rods is discussed. Experimental procedures, UO_2 samples, and the test facilities for the measurements are detailed. Data acquisition techniques are described. Results of experiments are analyzed in detail; data are presented in tabular and graphic form. 51 references. (M.L.S.)

33115 THERMAL NEUTRON DIFFUSION LENGTH IN LIQUID TERPHENYL. Goddard, A. J. H.; Tremeer, G. E. B. (Imperial Coll. of Science and Tech., London). Nucl. Sci. Eng., 37: 167-9 (July 1969).

The measurement of thermal neutron diffusion length in Santowax-R is described. Measured and calculated results are presented both graphically and tabularly. 14 references. (M.L.S.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 31474, 32068, 32069, and 32892.

33116 (DUN-SA-109) PREVENTIVE MAINTENANCE IN NUCLEAR PLANTS. Snyder, D. A. (Douglas United Nuclear, Inc., Richland, Wash.). May 1969. Contract AT(45-1)-1857. 20p. (CONF-690609-19). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

The effects of preventive maintenance on nuclear plant availability, reliability, and economics are analyzed. Example programs are described which utilize computers for processing maintenance performance records. 4 references. (D.C.C.)

33117 (IN-1228, pp 1-19) MATERIALS RESEARCH. (Idaho Nuclear Corp., Idaho Falls).

In H_2 embrittlement studies, irradiation of specimens increased the rate of H_2 occlusion and the apparent solubility after cathodic charging. Increased H_2 content from 0.2 to approximately 7 ppM resulted in a loss in ductility (reduction in area) of the unirradiated steels but without marked increase in the as-received material of susceptibility to hydrogen-induced cracking. Modification of the microstructure by heat treatment of A542 carbon steel resulted in a tendency toward hydrogen-induced cracking. Surveillance examinations of Be in the ETR revealed cracks in the reflector which had received a fluence of 1.7 to 2.3×10^{22} n/cm^2 E > 1 MeV. Examinations of other Be has given an essentially constant growth rate as a function of fluence of 0.02% per 10^{21} n/cm^2 E > 1 MeV, and electron transmission microscopy has shown that not all of the produced He can be ascribed to the bubbles resolved (25 to 130A). Specimens of cladding and structural materials for pressure vessels and high temperature usage are being irradiated in EBR-II for post-irradiation fatigue tests principally in support of the fast reactor program, although carbon steel specimens are also contained in the first two subassemblies. 6 references. (auth)

33118 (IN-1228, pp 20-73) REACTOR FUELS AND MATERIALS DEVELOPMENT. (Idaho Nuclear Corp., Idaho Falls).

The use of Al-B foils, fabricated by powder metallurgy procedures, and incorporated in the fuel plate between two halves of a wrought Al-U alloy is being investigated as a possible fuel fabrication technique for the ETR. Irradiation results indicate some performance improvement in B_4C-Al foils over B-Al foils. Blister-anneal tests produced failure at 400°F for burnups to 10^{21} fiss/cc. An ETR fuel element containing powdered UAl_x which had been irradiated to 6000 MWd at 2.56% of core power was evaluated and found to have had highly acceptable performance. Electron beam microprobe studies made on samples taken from a partially melted ETR fuel element fueled with powdered uranium-aluminide indicated that the fuel plate cores had reached temperatures of 1340 to 2460°F, and had not released appreciable amounts of fission products. Failure analysis indicated that large cold reductions (60%) used in the manufacture of Al-clad sample plates do not provide sufficient bond strength between the fuel plate core and cladding to resist swelling. A nondestructive test for B assaying was developed consisting of tagging the boron with ^{60}Co in order to permit detection by gamma scanning. The tagged B was incorporated as a glass in dispersion-type fuel plate cores using powder metallurgy procedures. An investigation of Si additions in Al-U alloys disclosed that when the Si-to-U atom ratios are below one the Si is concentrated in the intermetallic particles of the alloys. When this atom ratio exceeds unity the particles become saturated and the excess Si appears in the matrix of the alloy. Corrosion tests on a potential Al cladding alloy, 2219, followed by microprobe examination disclosed that Al in the base alloy preferentially migrates into the oxide corrosion layer leaving an enriched layer of Cu at the metal-oxide interface and a decreased Cu concentration in the corrosion layer. No Cu was detected in the water of the corrosion loop. Bulk UAl_3 pellets irradiation-tested at heat generations of 23 kW/linear foot have shown complete fission gas retention. 10 references. (auth)

33119 (IN-1228, pp 111-13) REACTOR TRAINING. (Idaho Nuclear Corp., Idaho Falls).

An ATR simulator consisting of duplicate console and analog computer for training reactor operators is described. (auth)

33120 (ORNL-TM-2532) DESIGN OF A LOOP FOR FISSION-PRODUCT DEPOSITION TESTS UP TO 1500°F. Gray, D. L.; Neill, F. H. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 35p. Dep. CFSTI.

The original fission-product deposition loop was modified to provide capability for simulating more realistically the temperature gradients in an advanced gas-cooled reactor circuit. A heater and cooler were added to permit operation of the test section to 1500°F. Both the isothermal and thermal gradient test sections were lengthened. The operating conditions and design capabilities of the modified system are presented. A comprehensive description of the loop components and auxiliary systems is included. 8 references. (auth)

33121 (ORNL-TM-2572) DESIGN AND TESTING OF A COINCIDENCE ELECTROMAGNET FOR REACTOR SAFETY SYSTEMS. Brown, William Douglas (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 63p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The development of magnets for use in reactor safety systems is reviewed. A discussion of basic magnetic circuit concepts is included. The design of one and three coil magnets is described. Methods used in magnet testing are discussed. 9 references. (D.C.C.)

33122 INVESTIGATION OF THE ACCURACY OF DIFFERENT SHIELDING CODES IN WATER-IRON SHIELDS. Fiebig, R. (GKSS, Geesthacht, Ger.); Frisius, F.; Nicks, R.; Penkuhn, H.; Ponti, C. Nucl. Eng. Design, 9: 281-301(Mar. 1969).

The limits of reliability and the errors are analyzed for shielding codes, namely: MAC-RAD, SABINE and RESTRAB based on the Spinney method, and NIOBE and BIGGI that solve numerically the transport equation. The comparison and the systematic analysis of the differences between the predictions and the measurements, allows to test the accuracy of the codes, and to interpret, where possible, their deviations in terms of geometrical description, physical model, and nuclear data employed. 14 references. (auth)

33123 SIGNIFICANCE AND PROBLEMS IN THE DEVELOPMENT OF PLUTONIUM FUELS. Murata, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Denryoku Shinpo, 14: No. 12, 33-7(Dec. 1968). (In Japanese).

The development of Pu fuels in Japan is described in the following: long-range aspects of the Pu fuel development; short-range aspects of the Pu fuel development; and problems involved in the development. (NSA of Japan)

GENERAL

33124 (AERE-R-5958) TRACES OF SPIN OPERATOR PRODUCTS AND THEIR USE IN PHYSICAL PROBLEMS (SPHERICAL BASIS). Dalton, N. W.; Rimmer, D. E. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1968. 248p. Dep. CFSTI. UK 32s. 6d.

The following traces of products of spin operators, $S_{\alpha i}$, were evaluated on a computer, $(\alpha 1, \alpha 2, \ldots \alpha n) = \text{Trace } \{\bar{\rho}_0 \bar{S}_{\alpha 1} \bar{S}_{\alpha 2} \ldots \bar{S}_{\alpha n}\}$ where $\alpha i = +1, 0, -1$ and $\bar{\rho}_0$ is equal to either $(2S+1)^{-1}$ or $e^{-L\bar{S}_z}/\text{Tr}\{e^{-L\bar{S}_z}\}$. Physically L is proportional to an external magnetic field, H, acting in the z-direction. All possible traces of up to nine spin operators are tabulated for the finite field case ($L \neq 0$) and of up to twelve spin operators for the zero field case ($L = 0$). Different methods for evaluating the traces are described and examples of applications of these tables are given. (auth)

33125 (BNL-13591) $1/|f|$ NOISE IN PHYSICAL MEASUREMENTS. Radeka, Veljko (Brookhaven National Lab., Upton, N. Y.). [1969]. 28p. (CONF-690515-1). Dep. CFSTI.

From International Nuclear Electronics Symposium, Stresa, Italy.

Low frequency divergent noises with spectral density $|f|^{\alpha}$, where $\alpha \leq -1$, and their effect on physical measurements, with special reference to $1/|f|$ noise was examined. This class of noise is widespread in nature, and it presents unique limitations to the measurement accuracy. In an attempt to present a picture of this noise with regard to the measurements of observable physical quantities, the questions about generation of noise, its divergence, correlation properties and measurements of variance are discussed. A statistical model for generation of low frequency divergent noises is used to consider the divergence problem in both the frequency and time domain. It is shown that $1/|f|$ noise is "weakly divergent," and that power limitation presents no reason to impose a low frequency limit within time intervals observable in nature. Correlation properties are discussed in terms of the time-dependent correlation function, using an ideal impulse response which generates low frequency noise from white noise. Two general models for generation of $1/|f|$ noise are summarized and discussed. Generation of $1/|f|$ noise from white noise over a limited frequency range by distributed and lumped-parameter filters is described. It is shown that the variance (i.e., mean square noise) is determined by the frequency limits of the observation method. The variance is independent of the low frequency limit of noise, if such a limit exists, and if the frequency limit of noise is lower than the low frequency limit of the measurement process. If the ratio of the high frequency limit and the low frequency limit of the measurement process is constant, the variance is a function of one parameter, τ, which is proportional to the "measurement time." For power-law noises, the variance $\sigma \propto \tau^{-1-\alpha}$. Variance in the case of a general power spectral density function can be represented by the power series, where each term $\tau^{-1-\alpha}$ may be associated with a power-law noise component. Thus, the measurement of variance as a function of measurement time represents a method for identification of power-law noises, and their effect under actual measurement conditions. (auth)

33126 (EGG-1183-1424(Rev.)) THE DIGITAL MICRODENSITOMETER AS AN OPTICAL SYSTEM COMPONENT. Revised. Technical Report L-927. Lorber, H. W. (EG and G, Inc., Las Vegas, Nev.). Feb. 26, 1969. 49p. Dep. CFSTI.

The effects of the sampling operation on the transfer function of an idealized digital microdensitometer are examined, and the respective roles played by input and output filters in the reduction of aliasing and the reconstitution of the sampled output are introduced. The idealization of the model is relaxed slightly so that the scanning aperture can be shown to act as an input filter. The filtering operation performed by the scanning aperture is discussed in more detail, but only in connection with the aperture's effect on supposedly known Fourier components of the input transparency. The notion that a transparency is a sample function of a random process is introduced, and the statistical communication theory of the 1940's is applied in the subsequent discussion. The concepts developed are applied in a quantitative discussion of aliasing phenomena in which some original material is introduced. (W.H.K.)

33127 (MLM-1641) SOLVENT EFFECTS IN QUICK-CURING FOAM SYSTEMS. Brown, L. E.; Nutter, J. D. (Mound Lab., Miamisburg, Ohio). May 28, 1969. Contract AT(33-1)-Gen-53. 7p. Dep. CFSTI.

The effects of dilute organic solvents on the interaction of vinylcyclohexene dioxide (VCD) and trimethoxyboroxine (TMB), two materials used in the development of a rapid-curing epoxy foam system, were investigated and compared with results from previous studies. The reactions were monitored calorimetrically. The results indicated that the TMB–solvent interaction predominates over the TMB–VCD interaction. Of the solvents tested the two materials were most reactive with each other in 1,2-dichloroethane. The results obtained compared favorably with those from previous studies. (auth)

33128 (NP-17862) HIGH SPEED INSTRUMENTATION OF EXPLOSIVE PHENOMENA. Report 330. Seddon, K. C. (Defence Standards Labs., Maribyrnong (Australia)). Feb. 1969. 21p. Dep.

Recent developments in the techniques and equipment used for the high speed instrumentation of explosive phenomena are discussed as the result of a visit to Sweden, Canada and U.S.A. during June–August, 1968. (Australia)

33129 (SCL-DC-68-121) INTEGRATED ENGINEERING DRAWING CONTROL SYSTEM. Bjork, G. V. (Sandia Labs., Livermore, Calif.). Mar. 1969. Contract AT(29-1)-789. 12p. (CONF-690514-1). Dep. CFSTI.

From 18th Annual Convention of the National Microfilm Association, Boston, Mass.

The drawing control system used at Sandia Laboratories, Livermore, encompasses the origination, identification, and revision of drawings; the physical control of drawings, intermediates, and microfilm aperture cards; a computerized drawing control system; and the maintenance of records on magnetic tape. The methods, flow, and paperwork comprising this system are discussed. A list of equipment is included. (auth)

33130 (SC-DR-69-102) ON THE RELAXATION OF TIME INCREMENT REQUIREMENTS IN STRUCTURAL COMPUTER PROGRAMS. Krieg, R. D. (Sandia Labs., Albuquerque, N. Mex.). May 1969. 50p. Dep. CFSTI.

Stable time step increments in finite difference structural computer programs, such as DEPRØSS and UNIVALVE, have been shown to depend upon the propagation velocities of longitudinal and flexural waves. Since these structural response programs are based upon the elementary Bernoulli–Euler beam theory, bending waves become large as the mesh spacing is reduced, resulting in short time step increments and correspondingly long computer run times for numerical stability. In this note, the relaxation of time increment requirements is attempted by addition of rotary inertia in an approximate sense. Dispersion characteristics of flexural waves in this approximate scheme are investigated and compared to well-known theories for a cylindrical bar. Results of this study indicate that computer time savings with this approximate scheme are somewhat limited, and that the approximate equations of motion are not well behaved in a certain region. It is not recommended that this scheme be utilized in structural computer programs. (auth)

33131 (SC-RR-69-67) SMALL COMPUTER MASTER-SLAVE OPERATION VIA VOICE GRADE TELEPHONE LINES. Marcon, John Jr.; Rosborough, John R.; Cropp, Louis O. (Sandia Labs., Albuquerque, N. Mex.). May 1969. 41p. Dep. CFSTI.

How the DEC PDP8 family of computers, data sets, and an inexpensive interface have been combined with a moderate amount of software to provide the small computer user with an extremely reliable and flexible means to control remotely located computers with computers of the same family is described. Using this system, any desired master-slave operation can be achieved. This system can be easily adapted to families of computers other than the PDP8. (auth)

33132 (UCRL-50611) HYDROSTATIC PRESSURE CELL FOR PRESSURE-VOLUME MEASUREMENTS TO 5 KILOBARS. Keller, Harry B. (California Univ., Livermore, Lawrence Radiation Lab.). May 12, 1969. 15p. Dep. CFSTI.

A liquid high-pressure system to provide pressure-volume (PV) data to 3 kilobars has been developed and tested on representative samples of tuff (both dry and water-saturated) and oil shale. The methods of calibration and data reduction are discussed and a comparison is made between the present data and earlier data taken on similar samples using an all solid system. Since shear forces are absent in liquids, the system provides a truly hydrostatic environment and an expectation of low-pressure PV data of better quality for samples of all kinds. (auth)

33133 (UCRL-50612) EVALUATION OF HMX AND RDX RECRYSTALLIZED FROM DMSO. Scribner, Kenneth J. (Cal-

ifornia Univ., Livermore. Lawrence Radiation Lab.). Mar. 10, 1969. 29p. Dep. CFSTI.

Holston Army Ammunition Plant asked a number of its customers to examine, for acceptability, samples of HMX and RDX explosives prepared by a modified technique. LRL collaborated with the Pantex AEC Plant in this examination. For the most part the explosive samples looked very good; however, there were indications of a small amount of polymorphic phase other than the normal β in the HMX's. (auth)

33134 (UCRL-50619) APPROXIMATE INVERSES FOR A CLASS OF FUNCTIONALS. Hardy, John W. (California Univ., Livermore. Lawrence Radiation Lab.). May 12, 1969. 20p. Dep. CFSTI.

A brief review of the Newton-Raphson method extended by Kantorovitch to the solution of functional equations defined over normal linear spaces is presented. A simple extension of Newton's method is presented, along with a generalized Newton sequence. A concept for an approximate inverse to the functional is introduced. Families of inverse operators are then presented, with primary attention given to ordinary differential equations and the initial value problem. (auth)

33135 (UUIP-618) MODEL FOR THE NUCLEATION AND GROWTH OF VACANCY CLUSTERS DURING THE QUENCH OF PURE ALUMINIUM. Wiberg, J.; Bergstroem, Y. (Uppsala Univ. (Sweden). Inst. of Physics). Jan. 1969. 16p. Dep.

The development of intrinsic dislocation loops during a rapid quench can be divided into two stages. The first stage comprises the nucleation of vacancy clusters and the growth of these up to a critical size. During the second stage the clusters collapse to dislocation loops which grow by continued absorption of vacancies. Most previous studies have been devoted to the second stage which is relatively easy to study experimentally. In this investigation, a model for the first stage, the nucleation, and growth of vacancy clusters are presented. The basic assumption made is that the divacancies present at the quenching temperature act as embryos for the clusters. It is shown that this model gives results consistent with experimental evidence available for pure aluminum. With appropriate modifications the same basic idea should be applicable even to other metals. (Sweden)

33136 (UUIP-627) RELAXATION STUDIES BY LINE-SHAPE ANALYSIS IN HIGH-RESOLUTION NMR. Gestblom, Bo; Hoffman, Ragnar A. (Uppsala Univ. (Sweden). Inst. of Physics). Feb. 1969. 20p. Dep.

A study was made on the use of line-shape analysis in high-resolution NMR. Special attention was paid to other relaxation parameters than the rate constant. A theory was developed and applied to a two-spin system. (Sweden)

33137 U.K.A.E.A. LIST OF PUBLICATIONS AVAILABLE TO THE PUBLIC. Cumulation No. 13, January-December 1968. Harwell, Eng., Atomic Energy Research Establishment, 1969. 105p. HMSO 18s.

Bibliographic details are given of unclassified reports, translations, periodical articles, books, pamphlets, and patent specifications by UKAEA staff listed during 1968. 1612 references are included, classified into broad subject groups. (UK)

33138 NEUTRON BEAM FACILITIES AVAILABLE FOR UNIVERSITY USERS AT UKAEA ESTABLISHMENTS: ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, AND ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON. [London], Science Research Council (UK), 1967.

Details are given of single crystal diffractometers, powder diffractometers, time-of-flight spectrometers, triple axis spectrometers, polarized neutron equipment, elastic defect scattering instruments, small angle scattering equipment, hot source liquid spectrometers, ancillary equipment, and irradiation facilities. (UK)

33139 FUTURE OUTLOOK FOR THE APPLICATIONS OF NUCLEAR SCIENCE. Seaborg, Glenn T. pp 149-63 of Maria Sklodowska-Curie: Centenary Lectures. Vienna, International Atomic Energy Agency, 1968.

From Centenary Symposium, Warsaw, Poland. See STI/PUB-179; CONF-671055.

The uses of nuclear energy for peaceful purposes are discussed. Applications ranging from electric power plants to agriculture and medicine are described. The need for international cooperation in these endeavors is pointed out. (J.W.R.)

33140 NEW CONCEPTS IN EMULSION POLYMERIZATION. American Chemical Society Symposium Held at New York, New York, September 13-15, 1966. Hwa, Jesse C. H.; Vanderhoff, John W. (eds.). J. Polym. Sci., Part C, No. 27, 1-334(1969). (CONF-660907).

Twenty-two articles are included; a separate abstract was prepared for one of them. The remaining 21 articles contain information on: catalyzed emulsion polymerization; anionic emulsion polymerization; kinetics and mechanisms of emulsion polymerizations; semicontinuous emulsion polymerization; polymer size distribution in emulsion polymerization; stochastic contributions to latex polydispersity; packing efficiency in sediments of monodisperse latexes and bimodal latex mixtures; adsorption onto synthetic latices; displacement of hydrophilic colloids from particle interfaces; mechanism of detergent dialysis; relation between emulsion freeze-thaw stability and polymer glass transition temperature; and effects of monomer addition methods in emulsion copolymerization. (P.C.H.)

For an abstract of the individual paper see: 31367.